Part 2

Machine strength grading

Edinburgh Napier UNIVERSITY

School of Computing, Engineering & the Built Environment

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SIRT
Strategic Integrated Research in Timber

The basis of strength grading

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1. Grade some timber
2. Determine the actual properties of the graded timber
3. Convert this into design values

4. Assume that grading again will produce the same result as long as:
   - The resource does not change
   - The grading rules do not change

Remember

All models are wrong but some models are useful

Dealing with uncertainty

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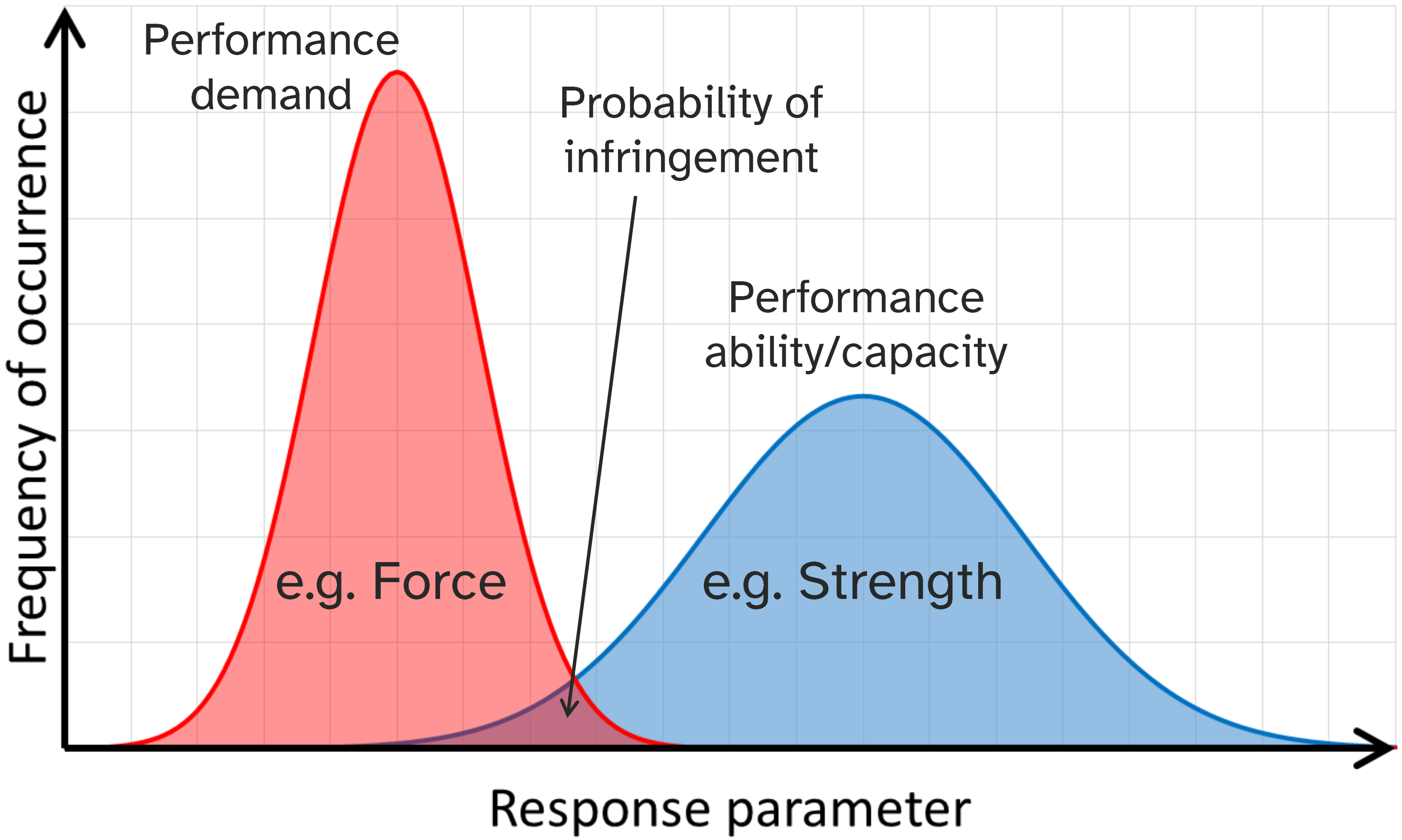

Statistics (as engineers see them)

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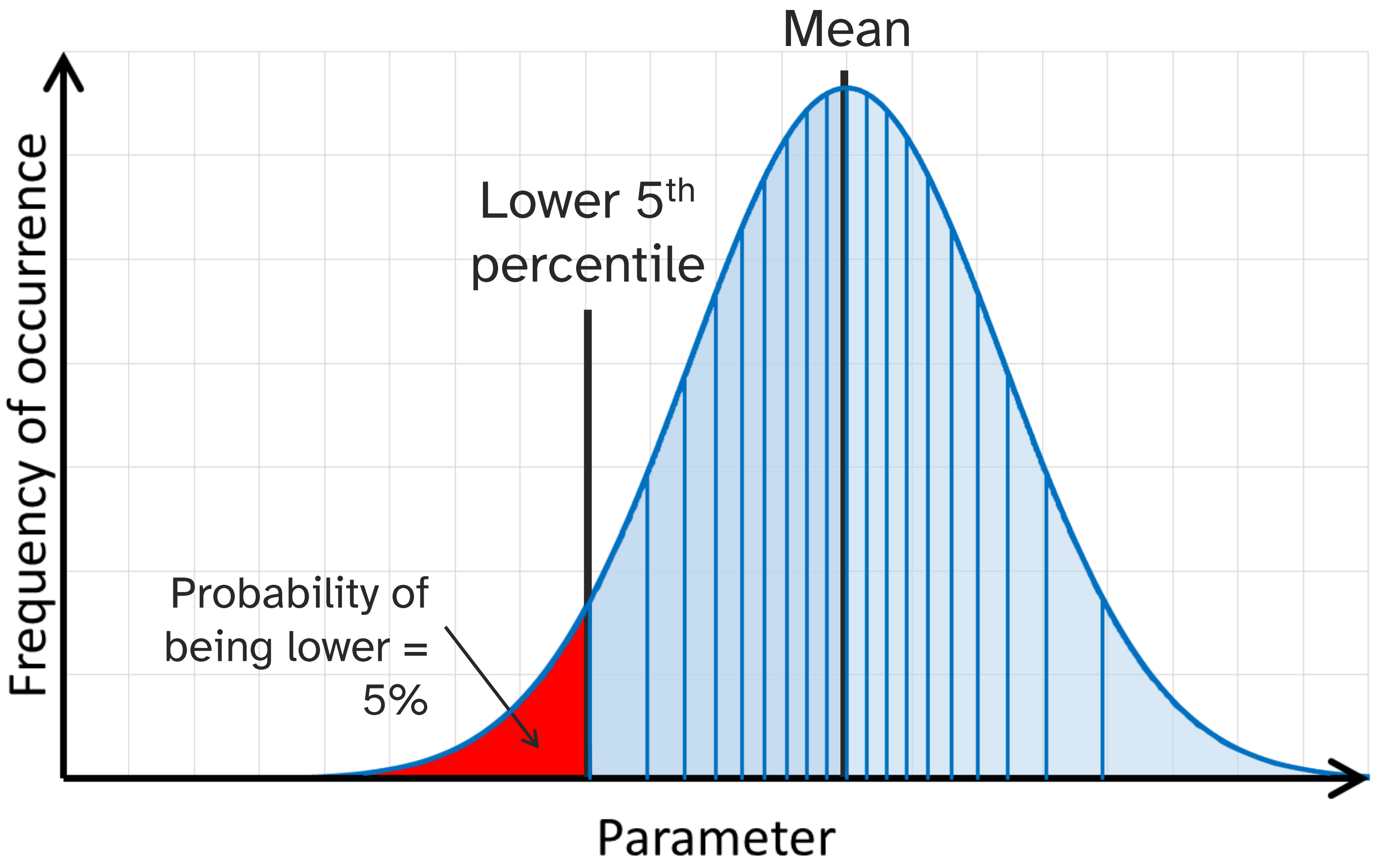

The aim of strength grading

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- Values for structural design (ref 12% moisture content)
- 'Primary' properties:
  - Strength (5^{th} percentile) (bending or tension)
  - Stiffness (mean)
  - Density (5^{th} percentile)
- 'Secondary' properties:
  - Numerous
  - Based on primary properties

Grading is about populations

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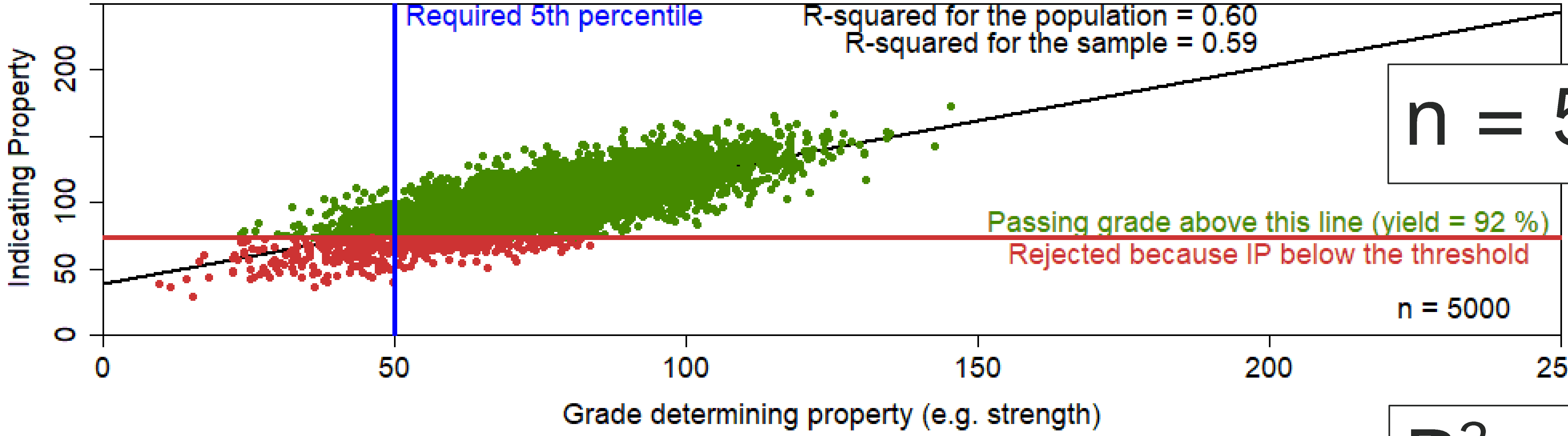
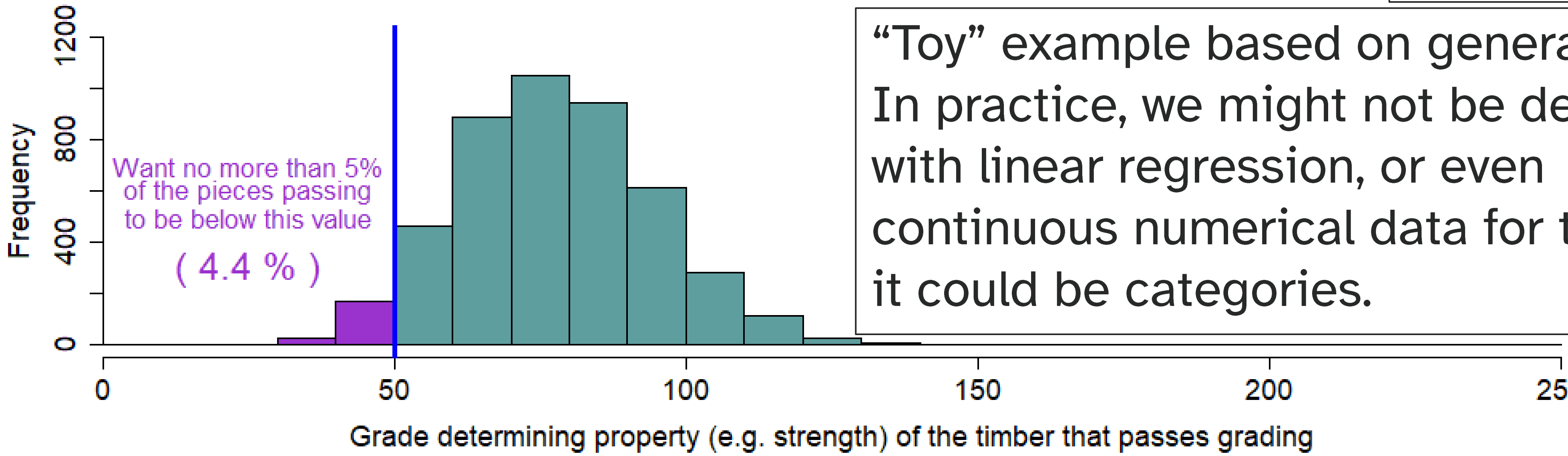


n = 5000

$R^2 = 0.60$



"Toy" example based on generated data
In practice, we might not be dealing with linear regression, or even continuous numerical data for the IP – it could be categories.

Grading is about populations

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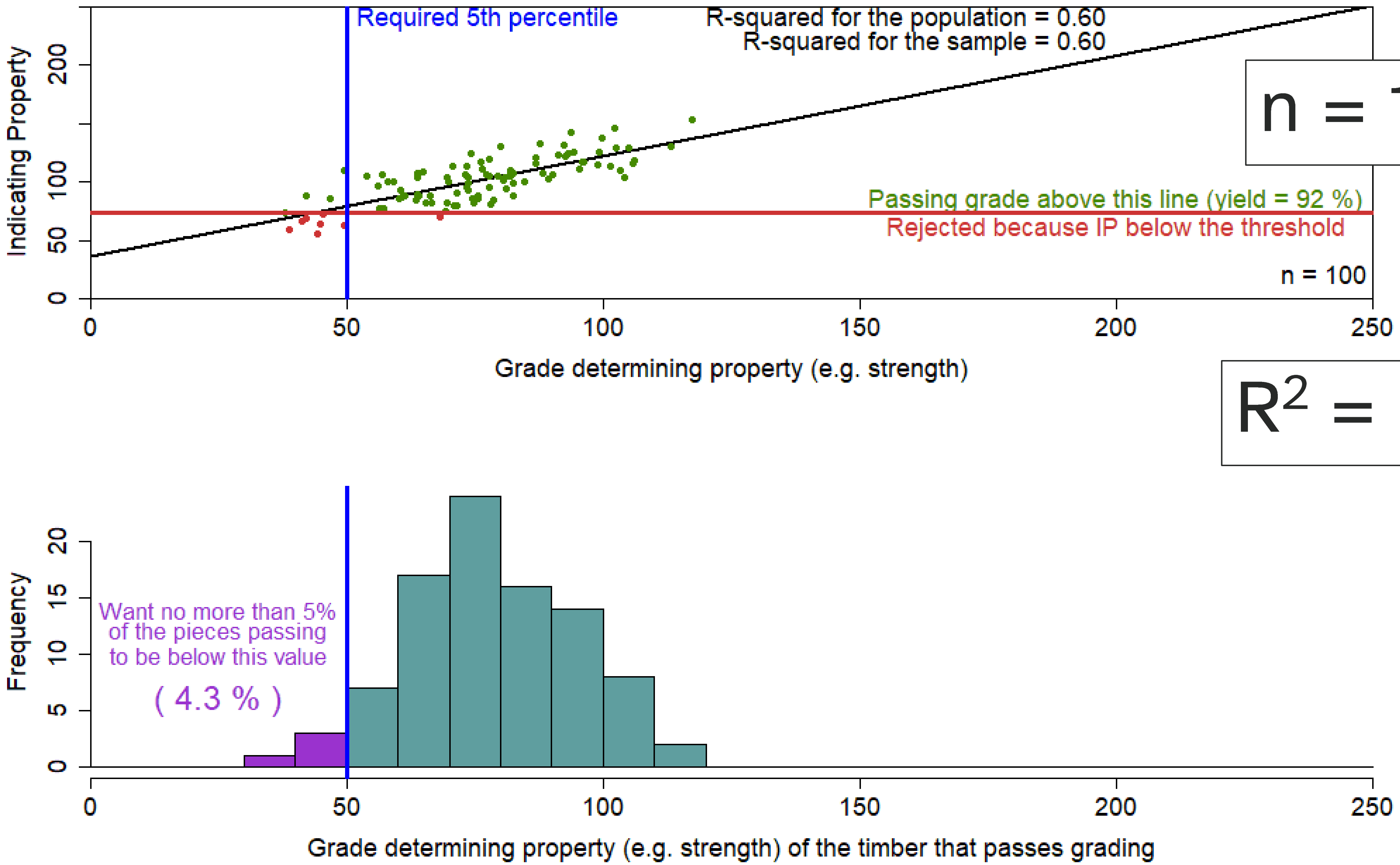

n = 100

$R^2 = 0.60$

Grading is about populations

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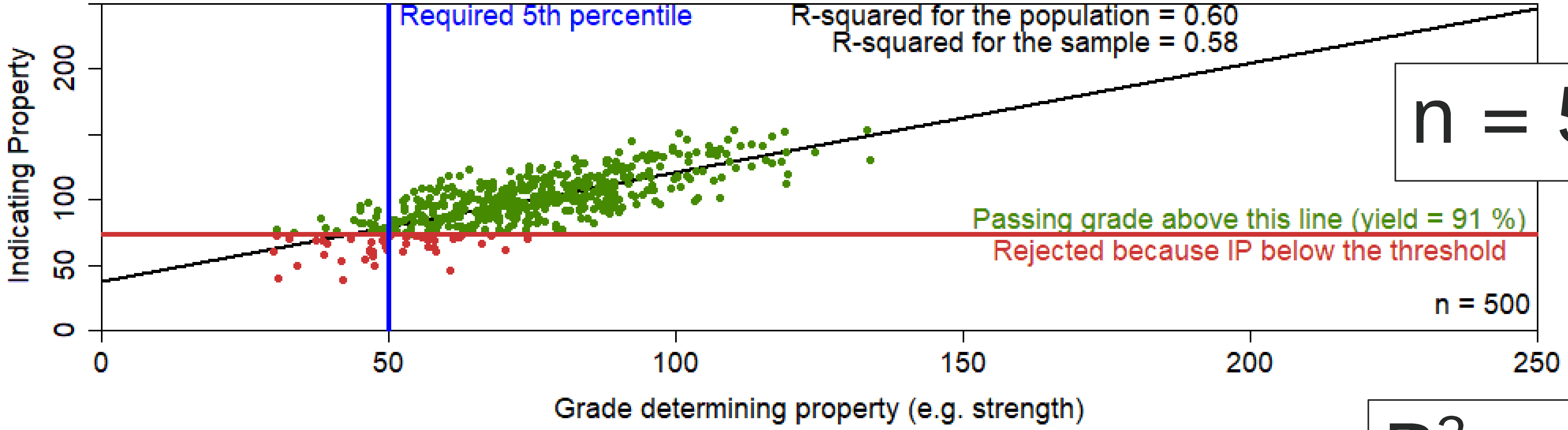
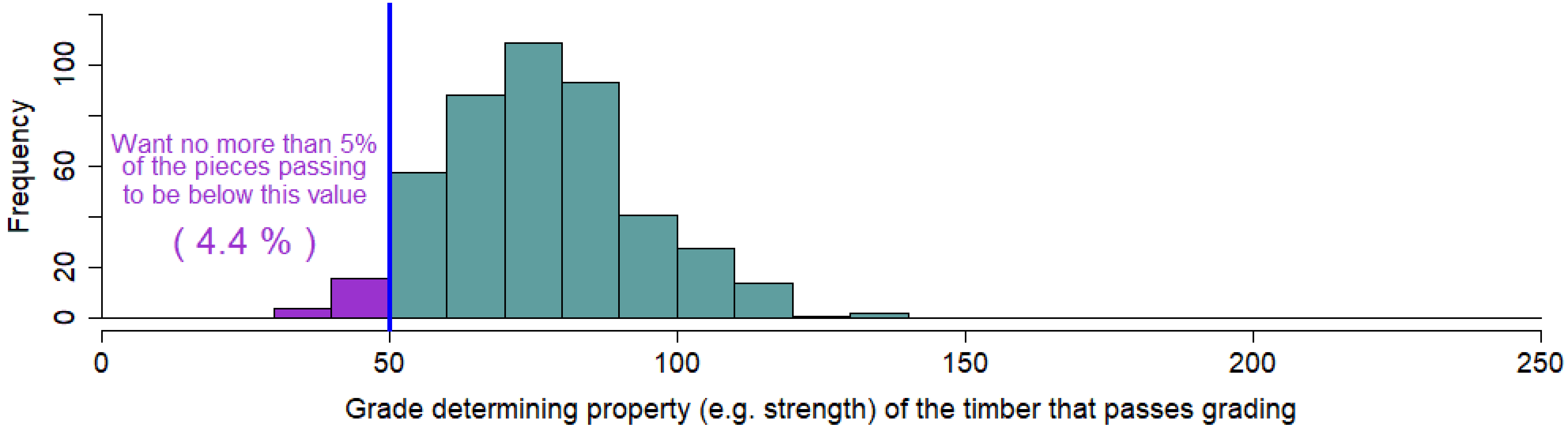


n = 500

$R^2 = 0.60$



Grading is about populations

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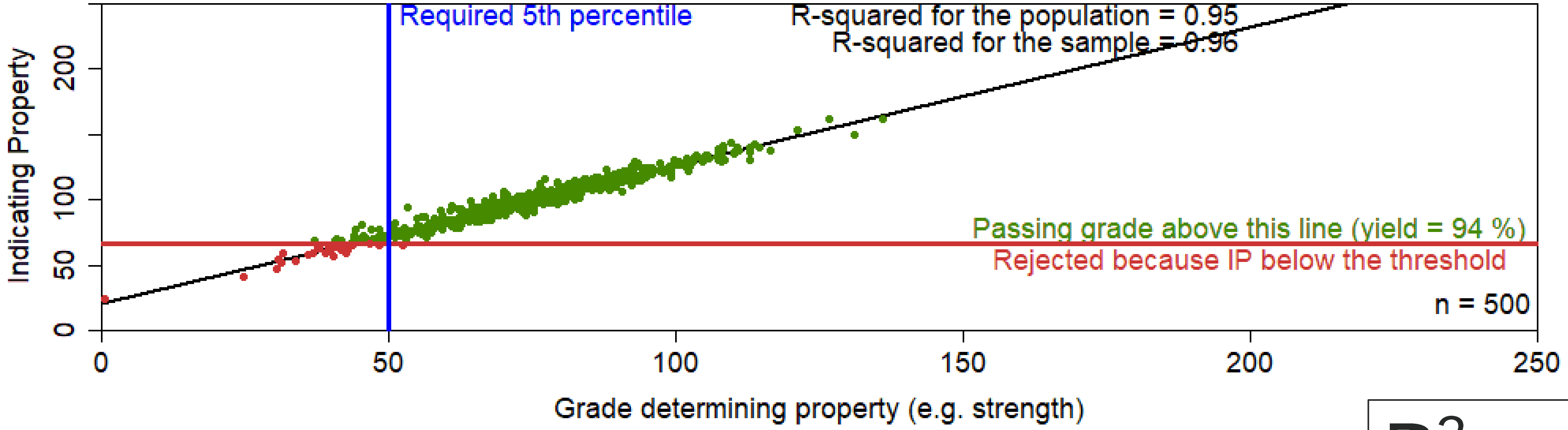
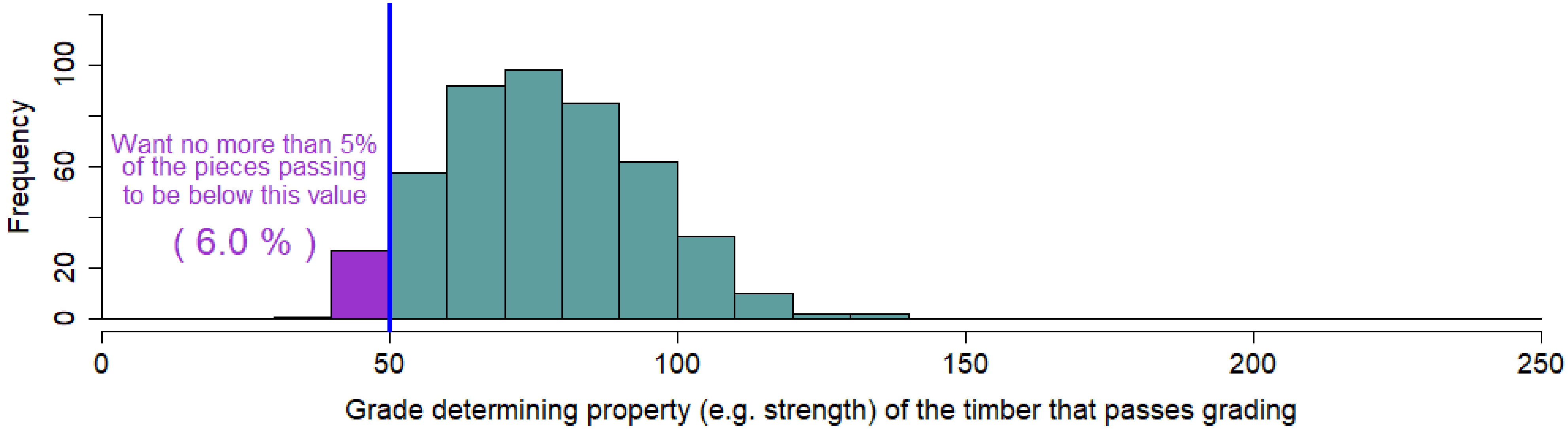
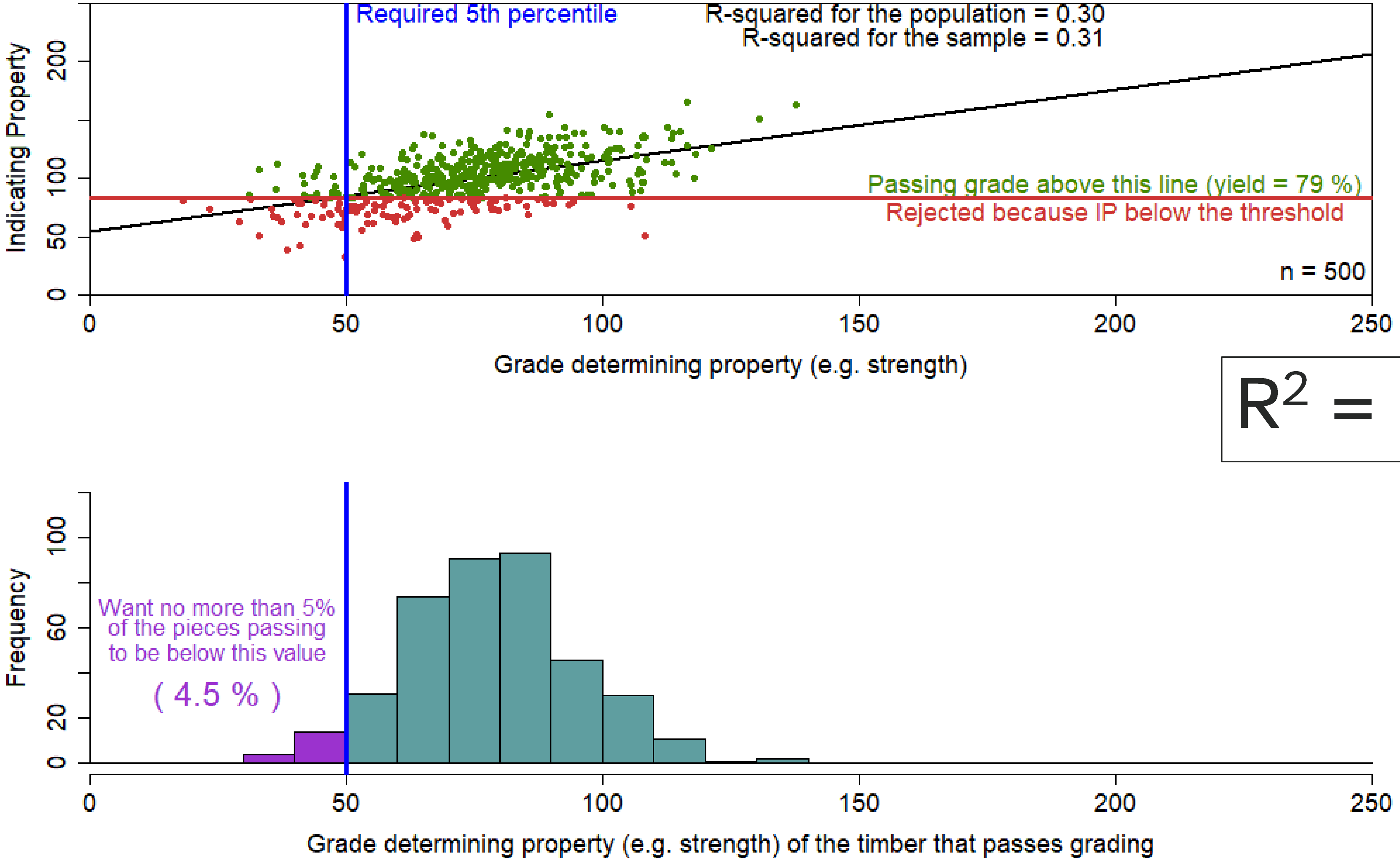


$R^2 = 0.95$



Grading is about populations



$R^2 = 0.30$

Grading is about populations

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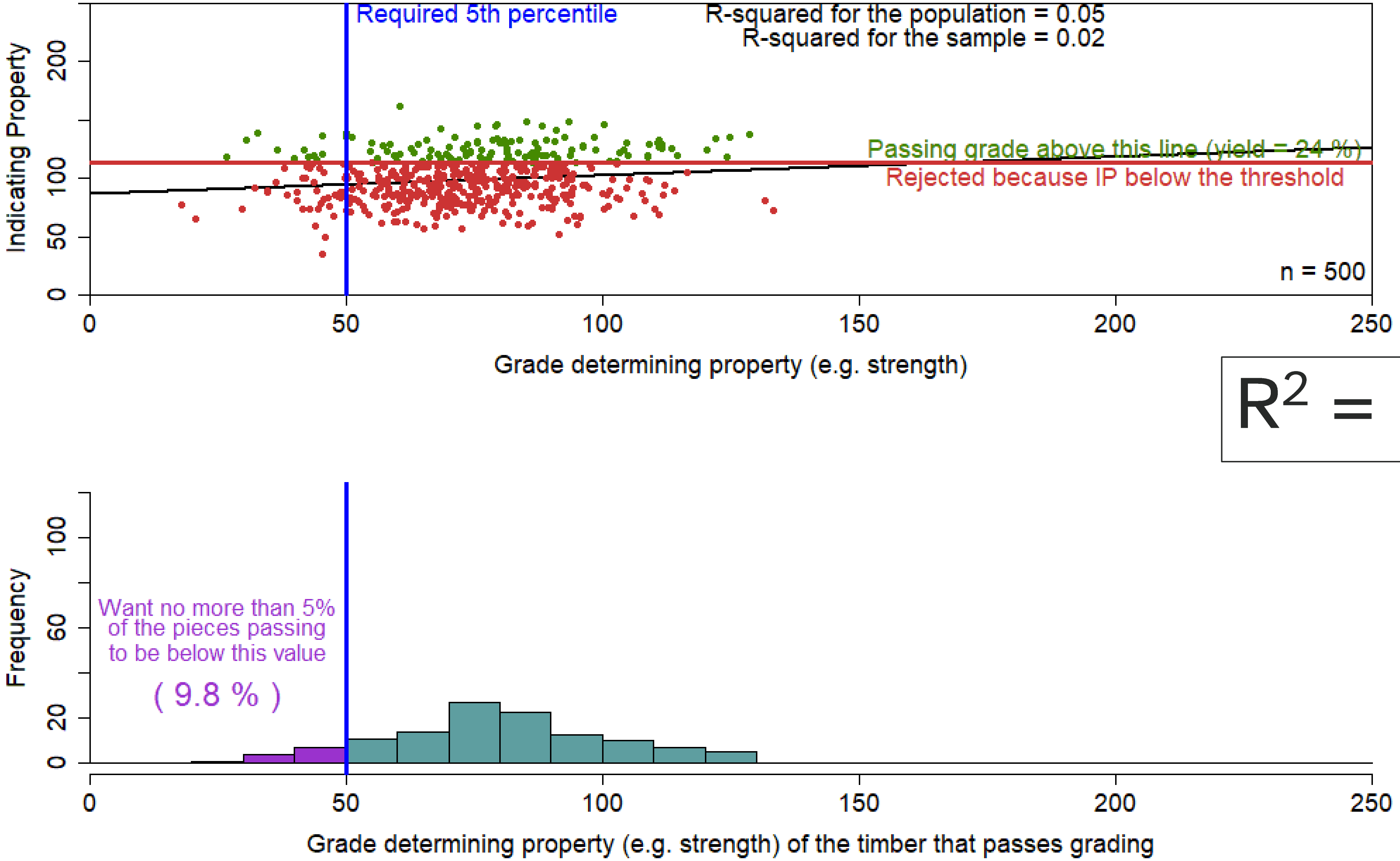

$R^2 = 0.05$

Grading is about populations

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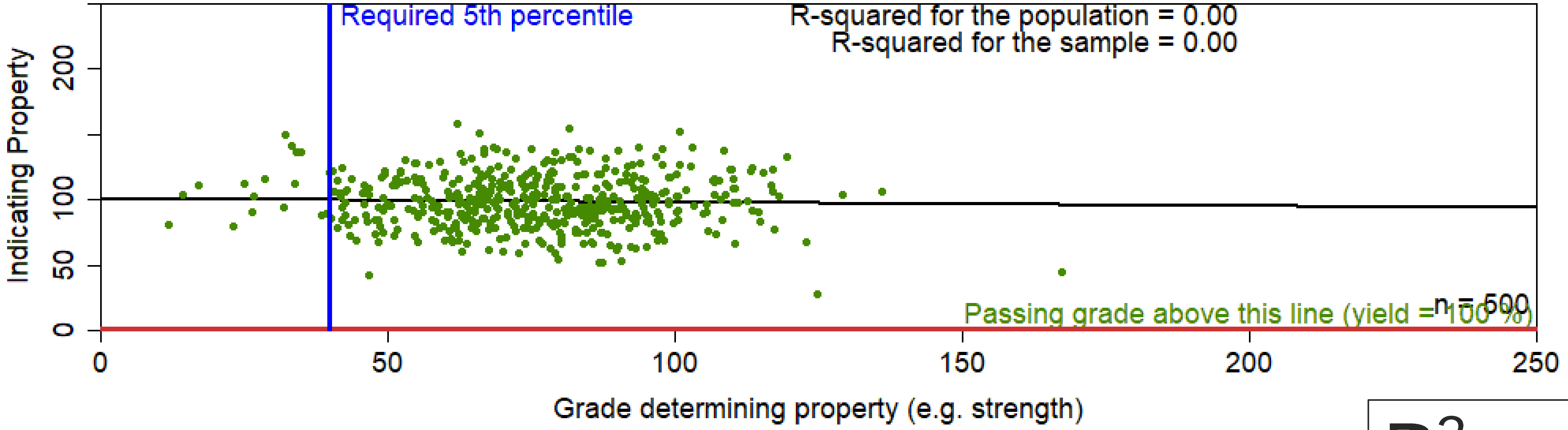
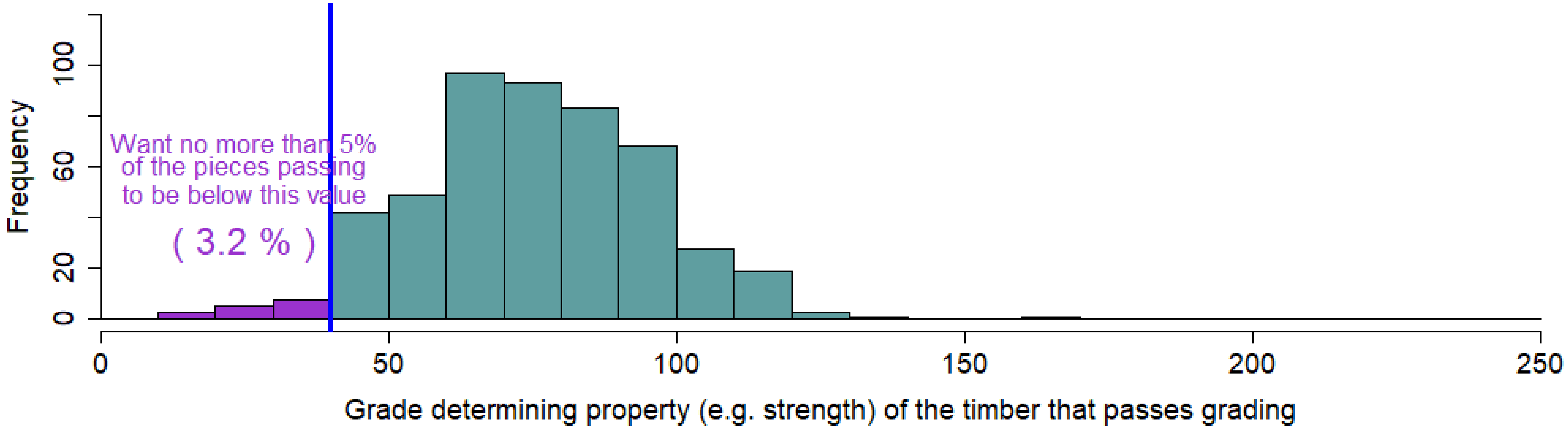


$R^2 = 0.00$

Reduced target – which passes anyway



Strength classes

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- EN 338
- Based on bending
  - Softwoods (& hardwoods) C14 … C50
  - Hardwoods D18 … D80
- Based on tension
  - Softwoods & ?hardwoods? T8 … T30

Name	$f_{m,k}$ (N/mm²)	$E_{m,0,mean}$ (kN/mm²)	ρ_k (kg/m³)
TR26	28.3	11.0	370
C16+	18.5	8.0	330
u12	12.0	6.0	290

Secondary properties

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- Based on bending strength:
  - Tension strength parallel to grain
  - Compression strength parallel to grain
  - Shear strength (or fixed)
- Based on bending stiffness:
  - 5th percentile stiffness parallel to grain
  - Stiffness perpendicular to grain
  - Shear modulus
- Based on density:
  - Compression strength perpendicular to grain
  - Mean density
- Fixed value (applies to all strength classes):
  - Tension strength perpendicular to grain

See EN 384 table 2

For tension grades, the primary property is tension strength (the type of testing, and bending strength is a secondary property)

Strength classes

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EN 338:2016		C16	C24	T14.5	D24
Strength (N/mm²)					
Bending	$f_{m,k}$	16	24	21	24
Tension parallel	$f_{t,0,k}$	8.5	14.5	14.5	14
Tension perpendicular	$f_{t,90,k}$	0.4	0.4	0.4	0.6
Compression parallel	$f_{c,0,k}$	17	21	21	21
Compression perpendicular	$f_{c,90,k}$	2.2	2.5	2.5	4.9
Shear	$f_{v,k}$	3.2	4.0	4.0	3.7
Stiffness (kN/mm²)					
Mean MoE parallel	$E_{?,0,mean}$	8.0	11.0	11.0	10.0
5%ile MoE parallel	$E_{?,0,k}$	5.4	7.4	7.4	8.4
Mean MoE perpendicular	$E_{?,90,mean}$	0.27	0.37	0.37	0.67
Mean shear modulus	G_{mean}	0.50	0.69	0.69	0.63
Density (kg/m³)					
5%ile density	ρ_k	310	350	350	485
Mean density	ρ_{mean}	370	420	420	580

Strength classes

EN 338:2009		C16	C24	T14.5	D24
Strength (N/mm²)					
Bending	$f_{m,k}$	16	24		24
Tension parallel	$f_{t,0,k}$	10 (8.5)	14 (14.5)		14
Tension perpendicular	$f_{t,90,k}$	0.4	0.4		0.6
Compression parallel	$f_{c,0,k}$	17	21		21
Compression perpendicular	$f_{c,90,k}$	2.2	2.5		7.8 (4.9)
Shear	$f_{v,k}$	3.2	4.0		4.0 (3.7)
Stiffness (kN/mm²)					
Mean MoE parallel	$E_{?,0,mean}$	8.0	11.0		10.0
5%ile MoE parallel	$E_{?,0,k}$	5.4	7.4		8.5 (8.4)
Mean MoE perpendicular	$E_{?,90,mean}$	0.27	0.37		0.67
Mean shear modulus	G_{mean}	0.50	0.69		0.62 (0.63)
Density (kg/m³)					
5%ile density	ρ_k	310	350		485
Mean density	ρ_{mean}	370	420		580

Strength classes

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- Are just a convenient way of declaring properties
- Not all are available on the market
- EN 338 classes can change (and have done several times)
- Fit OK to mainstream species
- Don’t fit so well to others
- Other strength classes exist (not in EN 338)
  - E.g. TR26, C16+

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Strength classes

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- Actual properties can be higher
- Importantly, actual density can be much higher
- The range of properties we expect to see within strength classes overlaps

C16 and C24: Strength

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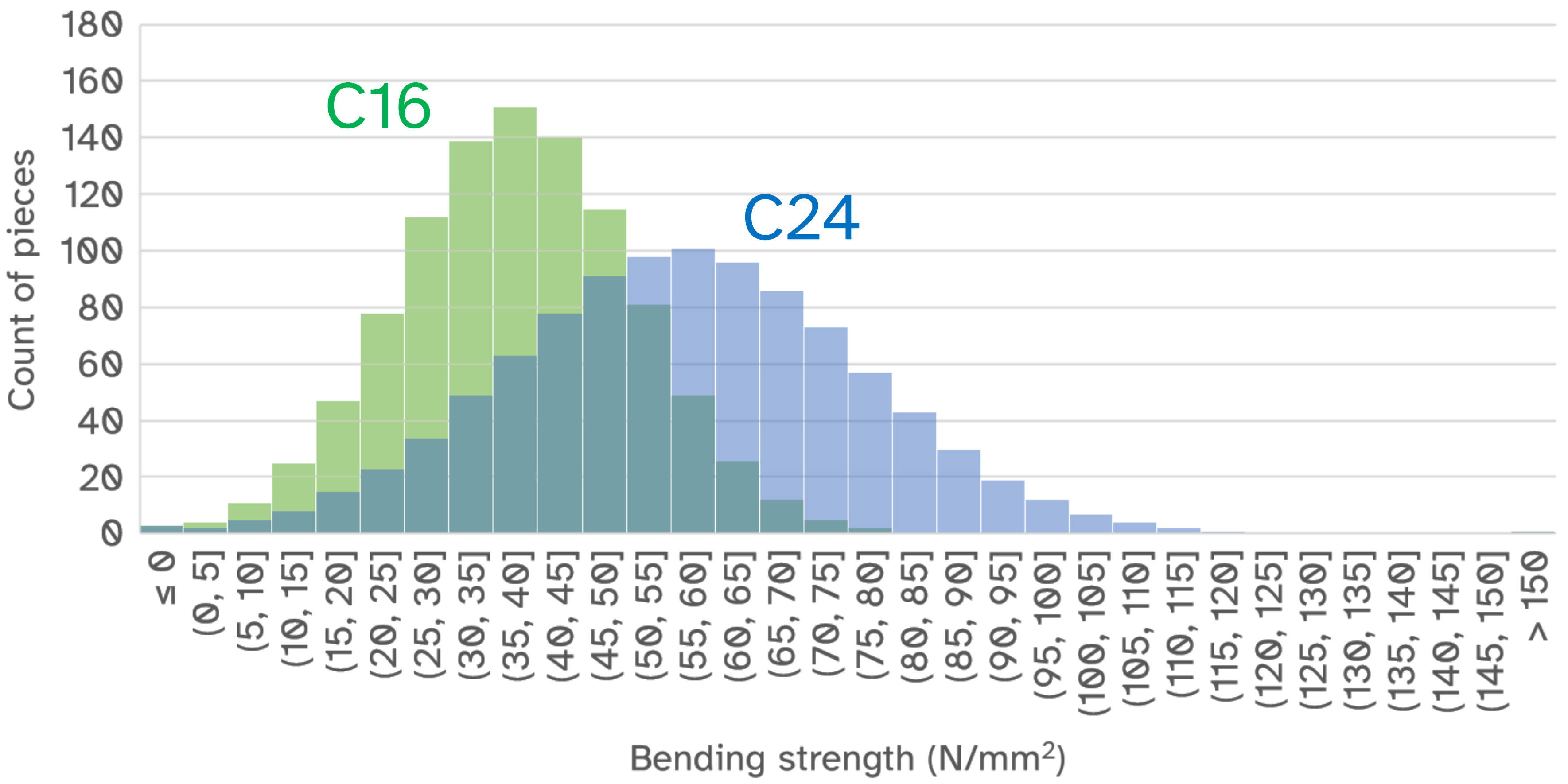

(Typical coefficient of variation 30 to 40%)

C16 and C24: Stiffness

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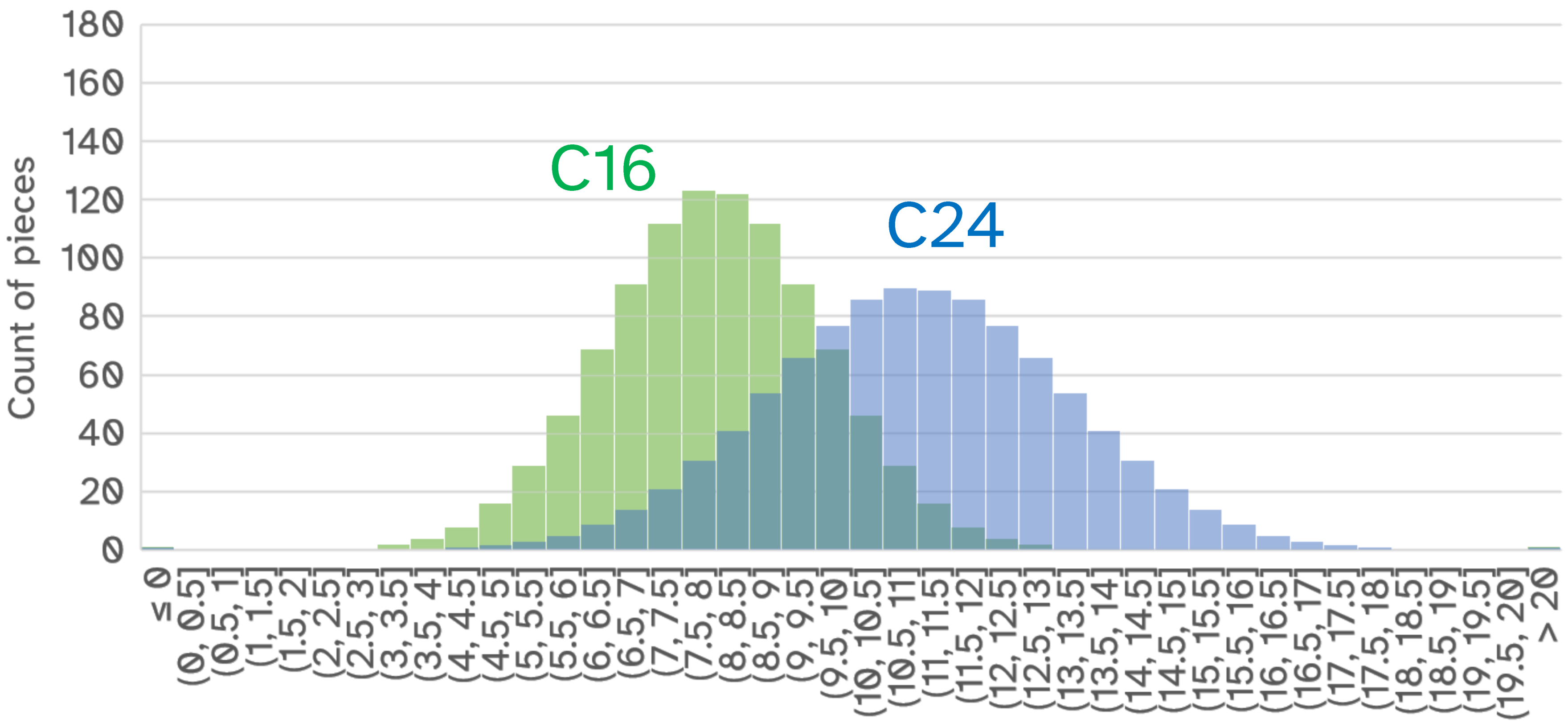

(Typical coefficient of variation 20%)

C16 and C24: Density

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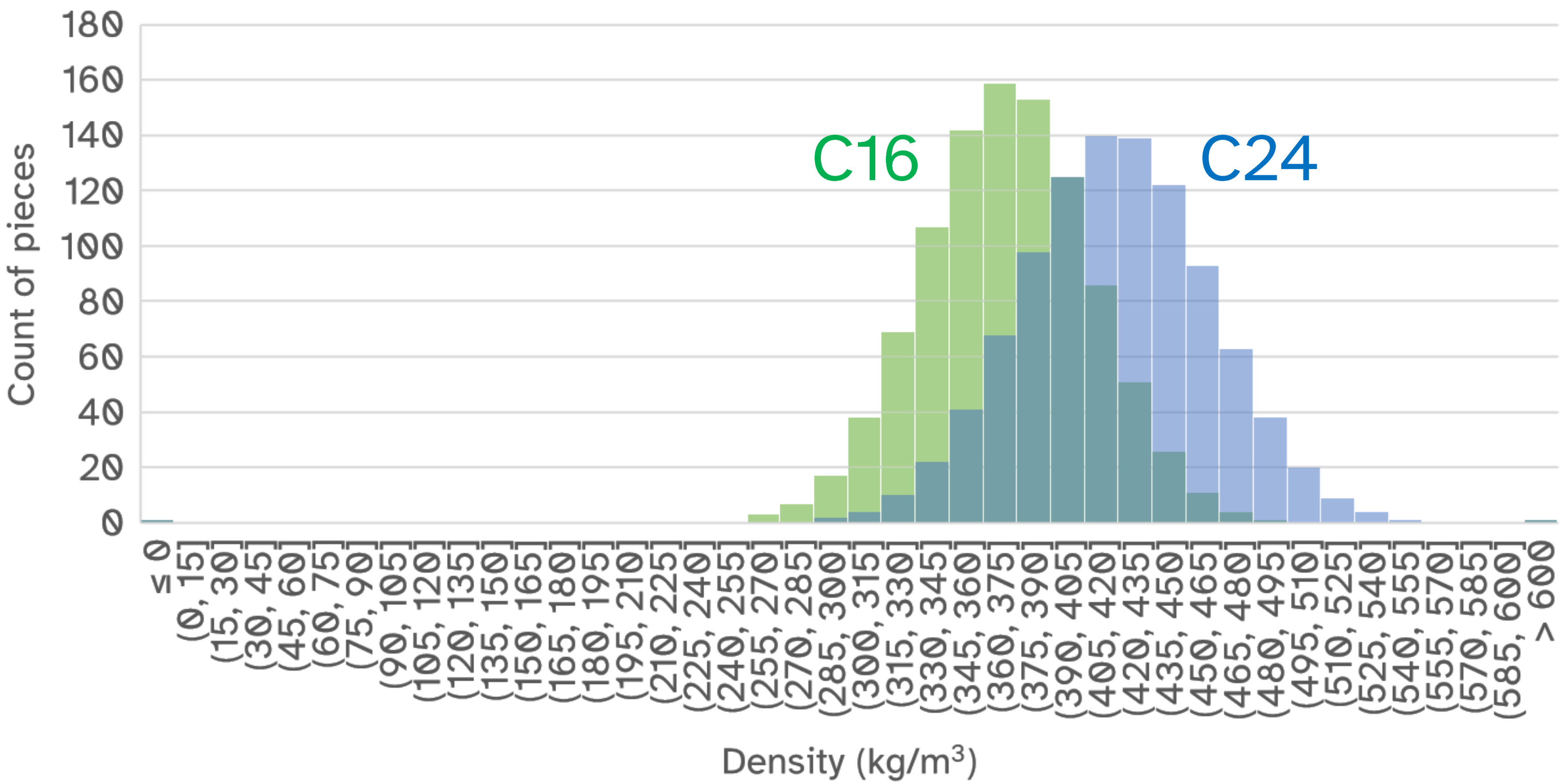

(Typical coefficient of variation 10%)

The evidence basis

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Visual grading

- Testing to modern standards
- Testing to older standards
- Long standing use without problems

Machine grading

- Testing to modern standards
- Testing to older standards

Machine strength grading

- Relates an ‘indicating parameter’ to the critical grade-determining parameter(s)
- Better accuracy than visual grading…
  …due to the parameters being measured
  …and the automation
  …so assignment to grade is less conservative
- Fast but expensive equipment
  (but getting some cheaper options)

A key thing about indicators

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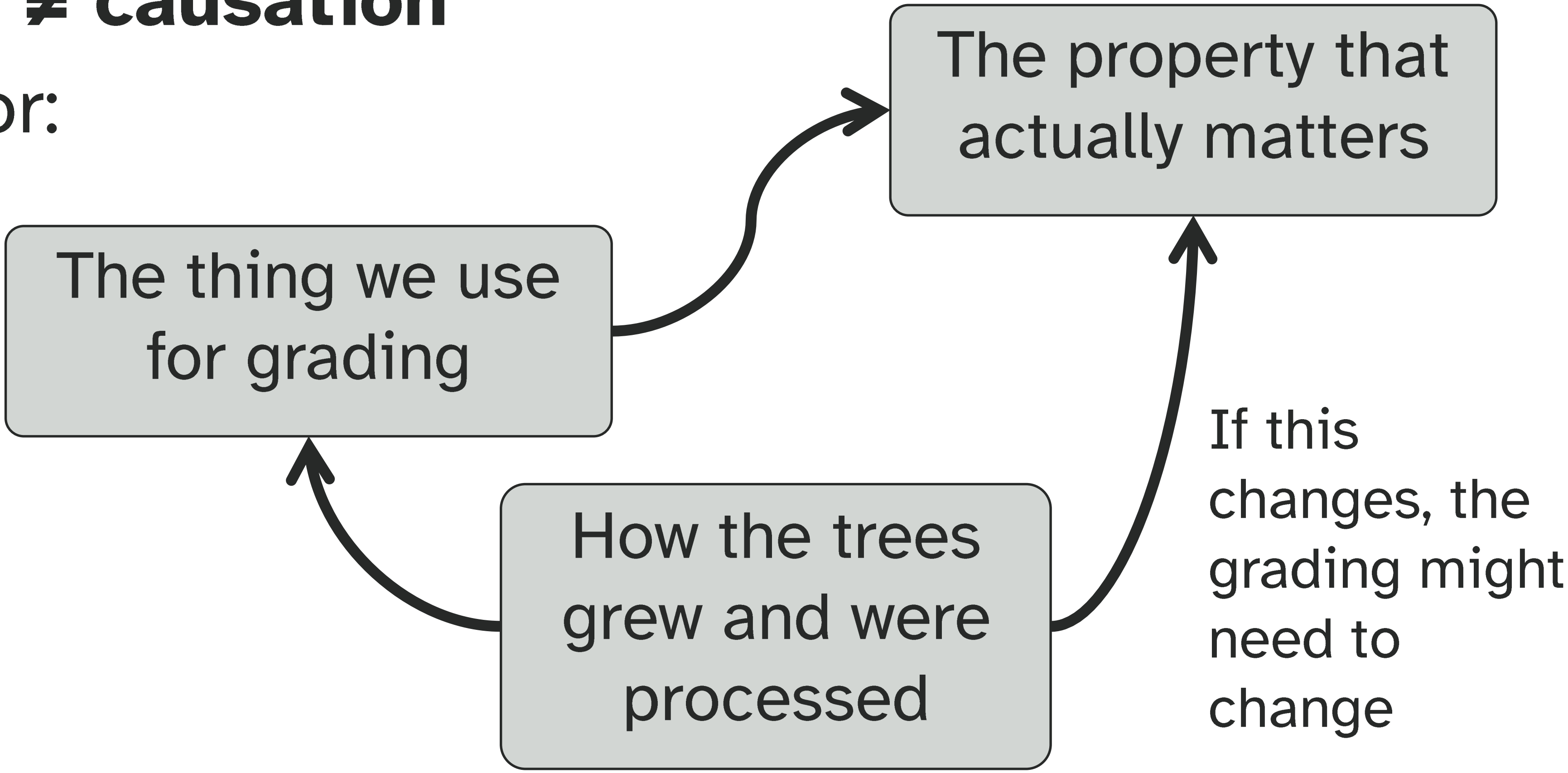
Useful for grading, but are often not deterministic

Correlation ≠ causation

Especially for:
Knots
Ring width
Density



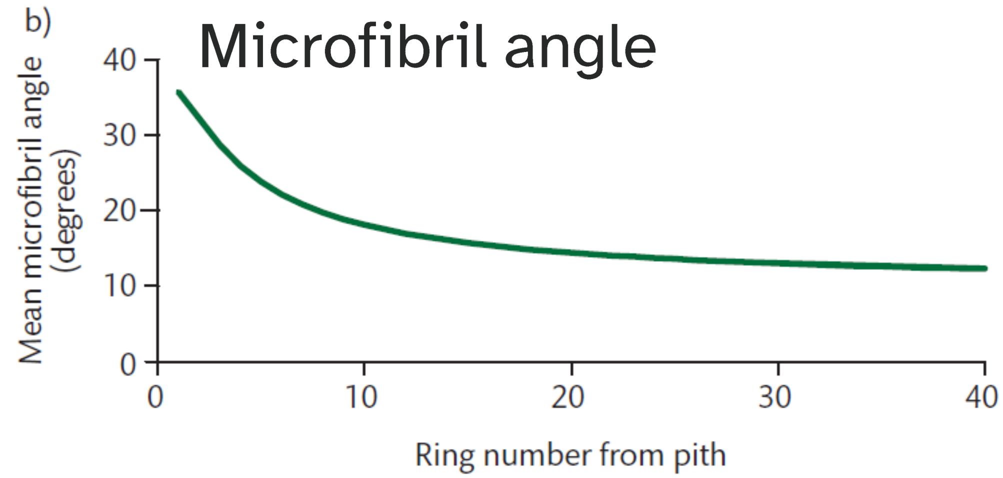
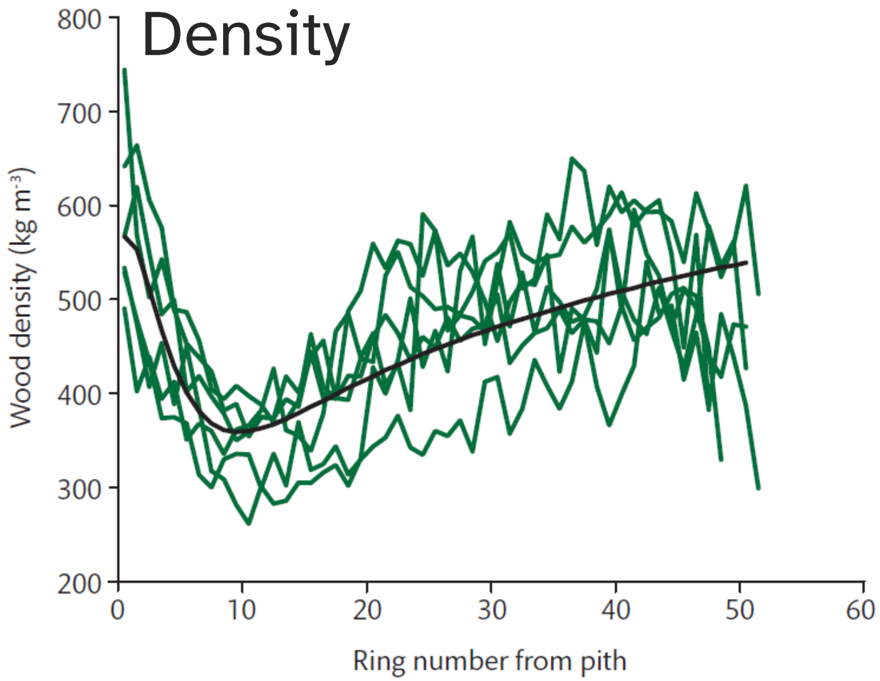
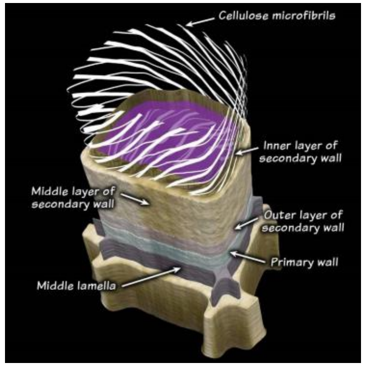


Figure 2.15 Radial profile of Sitka spruce wood density. The green lines show profiles for five individual trees sampled at Baronscourt in Northern Ireland, while the black line represents a model fitted to these data.





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Strategic Integrated Research in Timber

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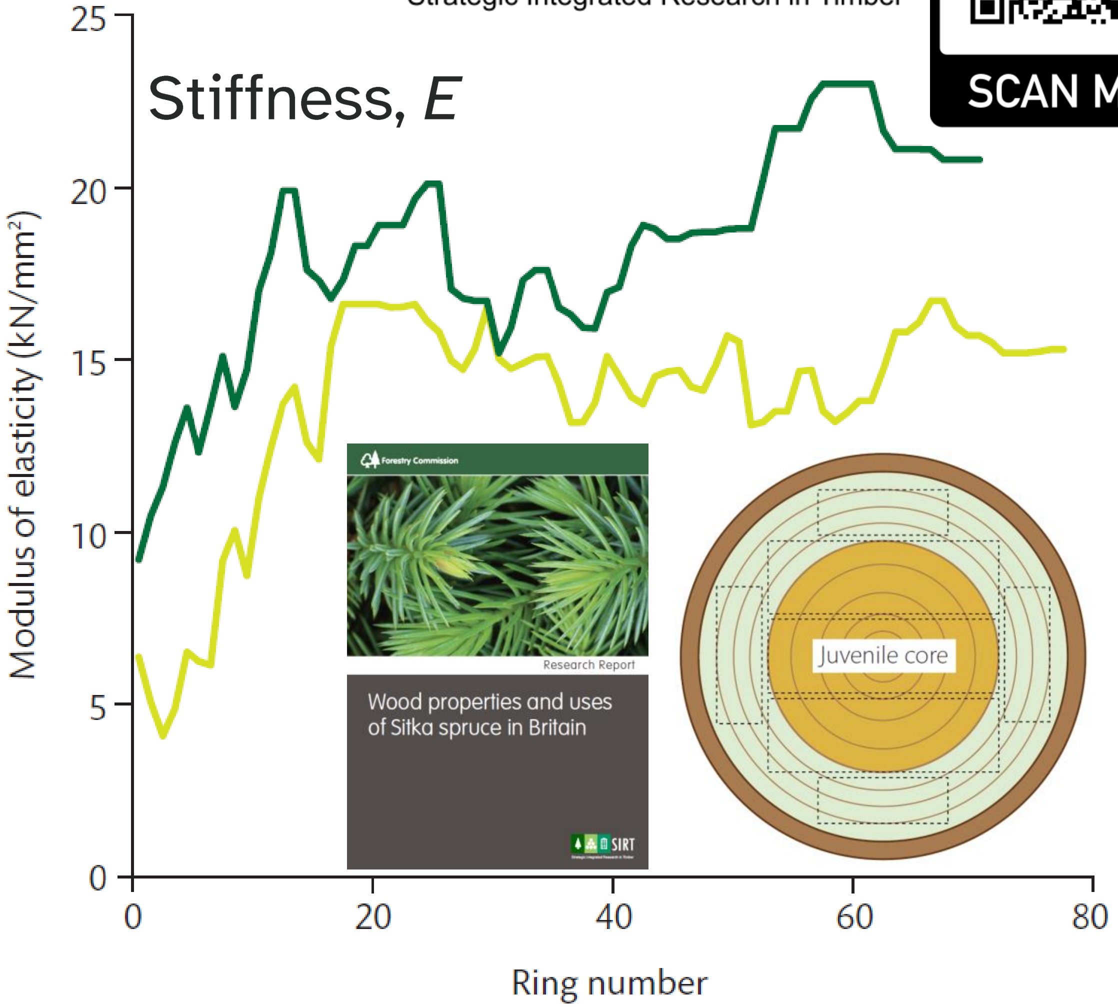

On “rate of growth”

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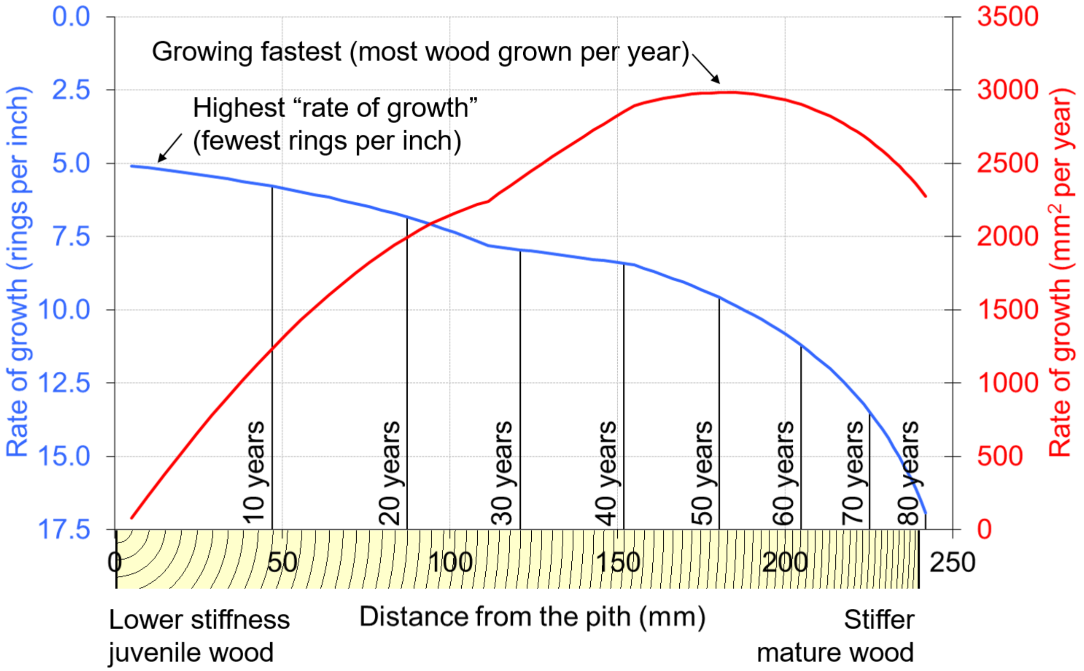

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- Ring width ≠ growth rate of the tree
- Even though you hear it a lot:
  - Wide rings doesn’t *mean* low density
  - Low density doesn’t *mean* low strength

Density and bending strength

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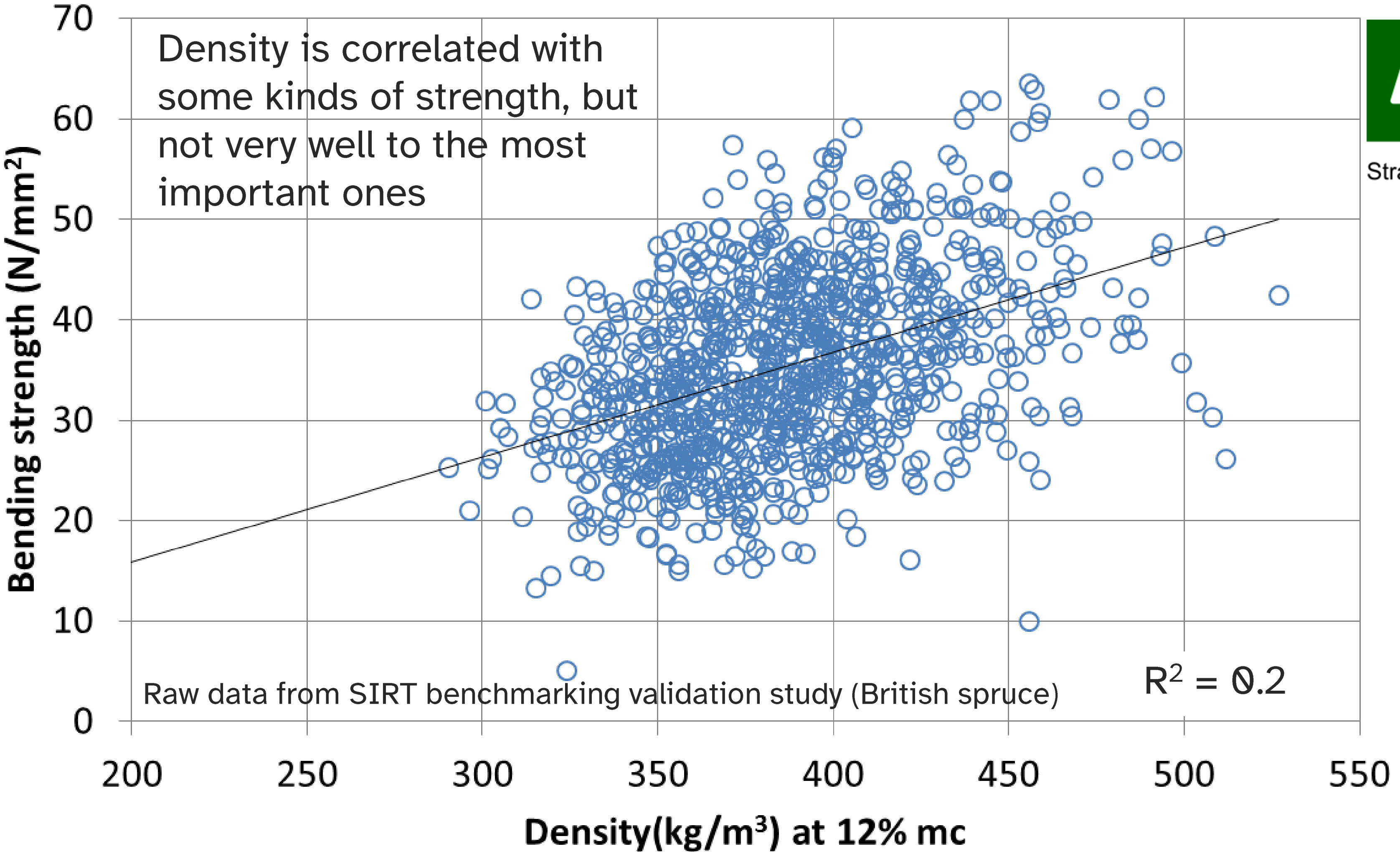

Species and growth area

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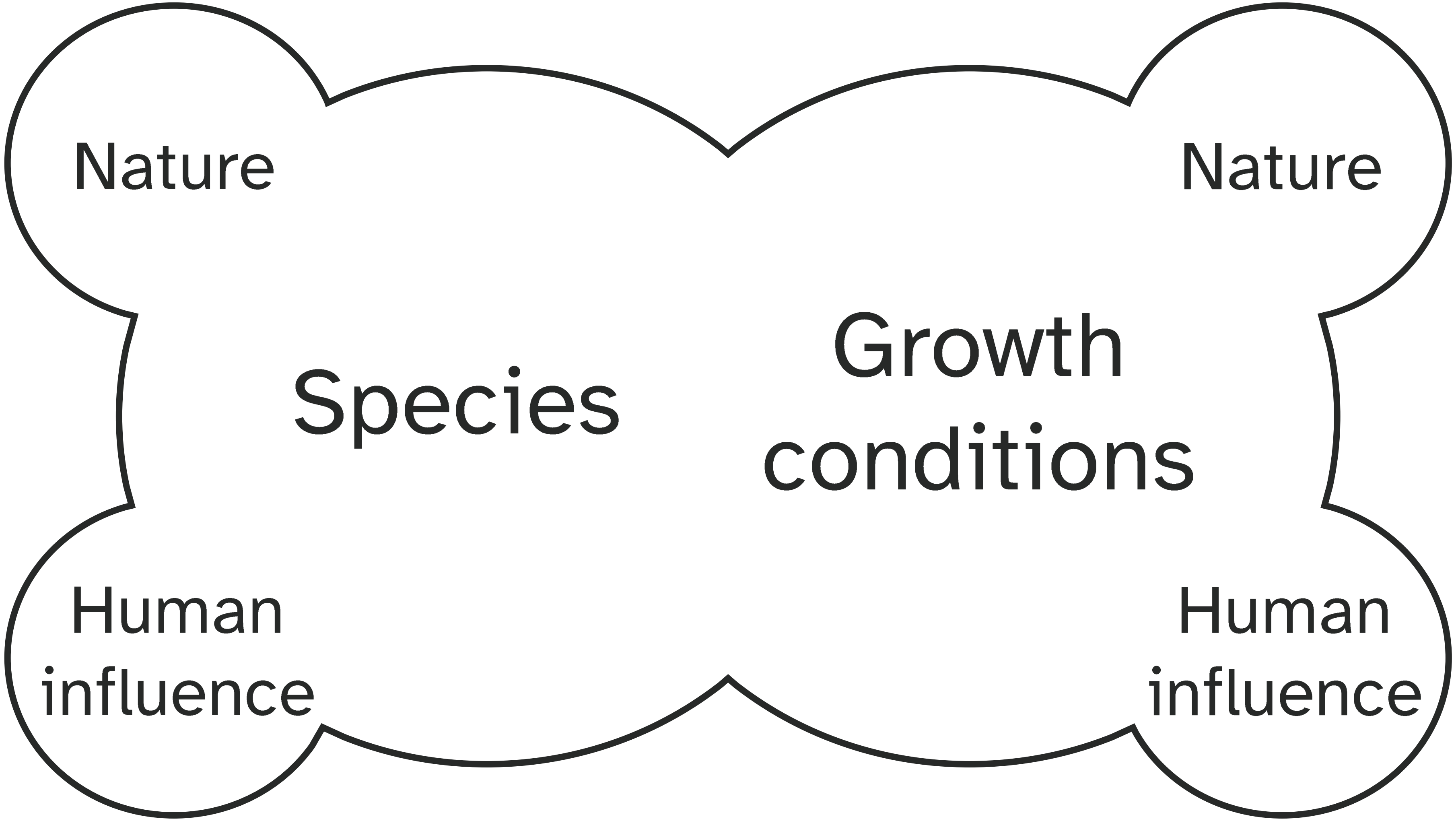

Bear in mind

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- For visual grading
  - Grading has to be done on knots, ring width etc
  - Means we see a visual difference between grades
- For machine grading
  - Can be done in several different ways
  - Often according to criteria we can’t see
  - Might not see much visual difference between grades

- So don’t judge machine grading by appearance!

The two types of machine grading

- Output control
  - Regular testing of output (costly)
  - But adapts the machine settings to optimise yield
  - Idea: some initial testing + continuous testing
- Machine control
  - Can be done without need for testing of output
  - Relies on strict assessment and control of machines
  - No regular fine adjustment of machine settings
  - Idea: large initial testing programme
  - (There is a new adaptive settings option)

Grading machine types

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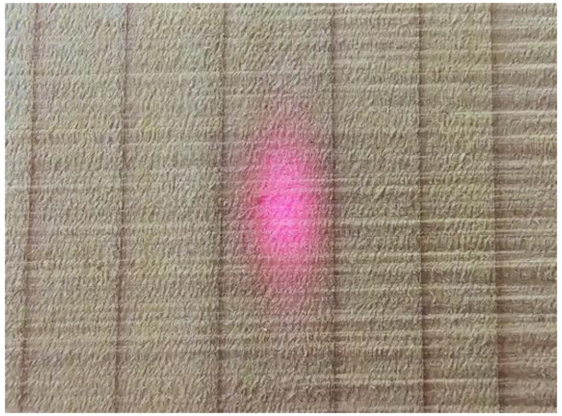
- Bending stiffness
  - Bending about the minor axis
- Dynamic (acoustic/vibration)
  - Essentially stiffness
  - May or may not include density
- X-rays
  - Knot size and position, density
- Surface scanning
  - Laser tracheid effect (grain angle)
  - Cameras and feature recognition
- Mixtures of the above
- IP models ranging from simple maths to machine learning



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Portable vs inline

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- Some machines are in-line
- Some machines are portable
- Some machines can be either

- If in-line there is a "machine installation check" to be done
- If portable, it cannot be done
- In-line machines benefit from the k_v factor on strength

The fancy end of technology

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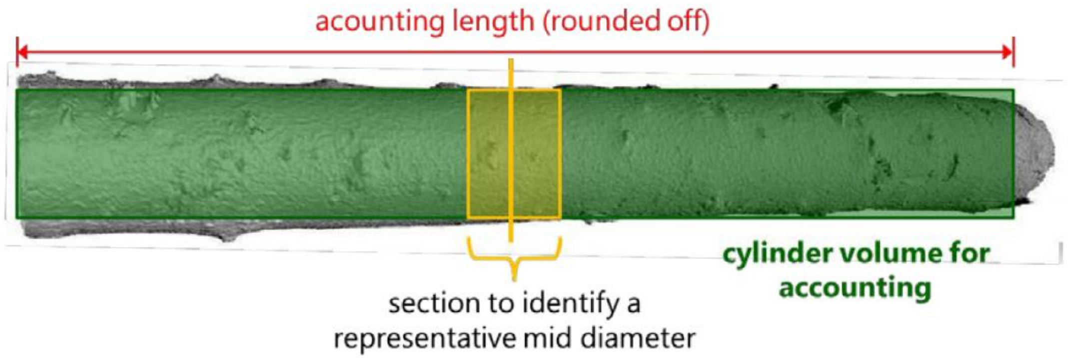
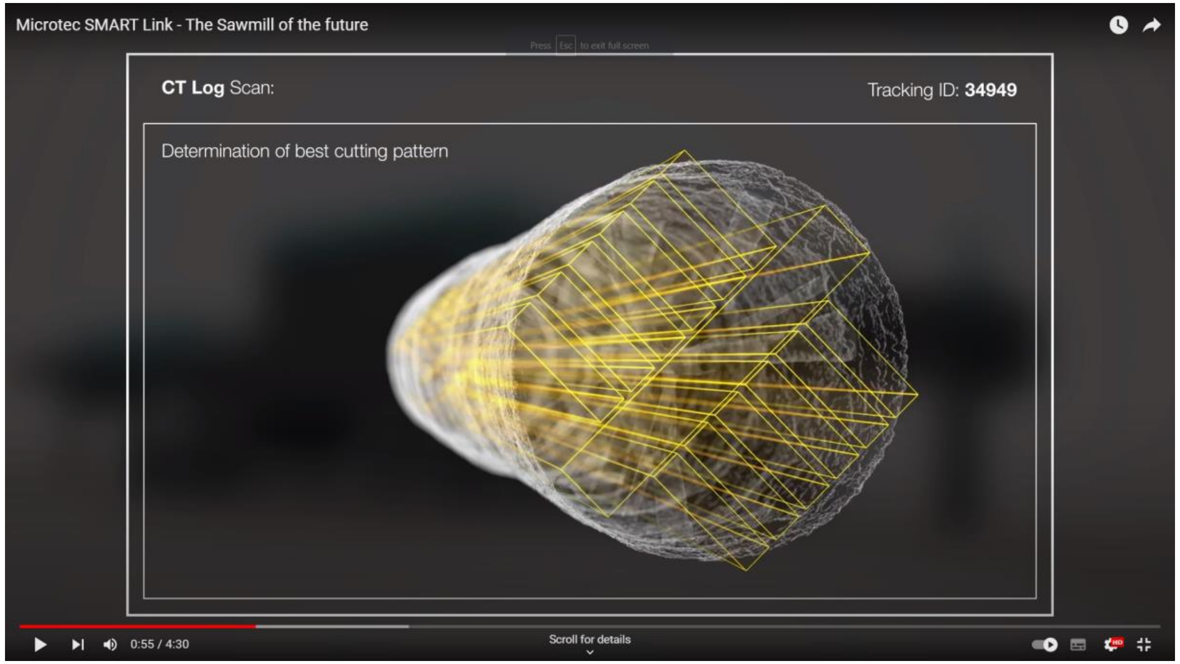


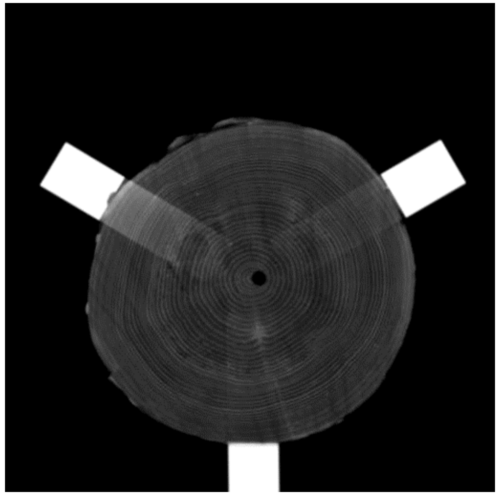
Figure 4— Methods for precise scaling and grading of saw logs using 3D-scanning systems (Sauter and Staudenmaier 2017)

Figure 5—Roundwood sawing optimisation according to X-ray based computed tomography; (Bruechert et al. 2017)



Data from
Johannes A. J. Huber

Luleå University of Technology
Wood Science and Engineering, Skellefteå, Sweden



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https://doi.org/10.1080/20426445.2022.2050549

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view the pdf to be sure the information displays correctly

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RESEARCH ARTICLE — OPEN ACCESS — Check for updates

Strength grading of timber in the UK and Ireland in 2021

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ABSTRACT
This paper summarises the state of the art for strength grading of construction timber grown in the United Kingdom and the Republic of Ireland. It includes the latest approvals based on recent research on spruce, larch and Douglas-fir. It lists the following information along with the primary references: visual grading grades and strength class assignments; grading machines with approved settings for machine control grading; the species, size ranges and strength class combinations covered; and grade determining properties of specific strength classes for the UK and Irish markets. This paper is useful for those grading timber, and those specifying UK and Irish grown timber.

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Accepted 1 March 2022

KEYWORDS
Grades; classes; machine strength grading; visual strength grading; structural timber; EN14081

Introduction

In Europe, structural timber is graded under the system set out by the European standard EN14081-1 and its supporting standards (e.g. Lycken et al. 2020). It sorts rectangular cross-section timber into categories based on required characteristic values of grade determining properties. For normal construction timber those primary (grade determining) properties are usually bending strength, bending stiffness and density (at 12% reference moisture content).

Instead of bending, grading can also be based on tension strength and stiffness. Either way, characteristic values of strength and density are specified as fifth percentiles and stiffness by the mean. No tension grading has yet been established for UK and Irish grown timber (although some testing has been done;

exchange timber market with logs crossing the border. This is one of the reasons that modern grading rules usually treat both countries as a single growth area, particularly for Sitka spruce but also more recently for Douglas-fir (Gil-Moreno et al. 2019b) and larch. Collaborative research between Edinburgh Napier University and the National University of Ireland Galway, in the 'Strategic Integrated Research in Timber' projects and the 'WoodProps for Ireland' programme have confirmed the timber to be suitably similar for the purposes of grading. The research has also shown that the resource is dissimilar to timber grown elsewhere in Europe, with grading tending to be limited by wood stiffness for spruce and larch, as opposed to strength in other places. This is due to differences in climate, forest management, species choice and seed selection,

Table 6. List of grading machines approved for machine control. In bold the machines with machine control settings available for UK and Ireland.

Manufacturer	Name	ID*	Description
Tecmach Ltd	***Cook Bolinders***	1	Mechanical bending
Measuring and Process Control Ltd	***Computermatic Micromatic***	2	Mechanical bending
VTT	*Raute Timbergrader*	3	Mechanical bending
Microtec s.r.l. – GmbH	*EuroGrecomat-702*	4	X-ray
	Goldeneye 702/802	5	X-ray
	EuroGrecomat-704	6	X-ray & mechanical bending
	Viscan	8	Longitudinal resonance
	EuroGrecomat-706	9	X-ray & longitudinal resonance
	Goldeneye 706/806	10	X-ray & longitudinal resonance
	Viscan Plus	20	Longitudinal resonance & X-ray density
	Viscan Compact	22	Longitudinal resonance & density
	Viscan portable with balance	29	Portable, longitudinal resonance & density
	Viscan portable without balance	30	Portable, longitudinal resonance
Microtec AB (Microtec Linköping)	*WoodEye Strength Grader*	31	Longitudinal resonance,density & laser tracheid grain angle
Microtec Innovating Wood Oy (Microtec Espoo)	*Finscan Nova*	36	Camera scanning (visual & near infrared)
	Finscan HD	37	Camera scanning (visual)
Dynalyse AB	*Dynagrade*	7	Longitudinal resonance
	Precigrader	12	Longitudinal resonance & density
Brookhuis Applied Technologies BV	***MTG 960***	11	Portable, longitudinal resonance & density
	mtgESCAN 962/966	14	Longitudinal resonance & density
	MTG 920	19	Portable, longitudinal resonance
	MTGbatch 962/966	23	Longitudinal resonance & density
	MTGbatch 922/926	24	Longitudinal resonance
	mtgESCAN 922/926	26	Longitudinal resonance
Dimter GmbH	*Grademaster*	13	Longitudinal resonance, density & knots
Luxscan technologies	***Escan FWM/FW***	14	Longitudinal resonance & density
	EScan FM/F	26	Longitudinal resonance
	OptiStrength XE	33	X-ray & longitudinal resonance
	OptiStrength X	34	X-ray
Concept Bois Structure SARL	*Triomatic*	15	Ultrasonic time of flight & pin indentation density
Automatisation J.R.T Inc	*CRP*	16	Mechanical bending
XYLOMECA	*Xyloclass T*	17	Longitudinal resonance & density
	Xyloclass F	21	Flexural resonance & density
SARL Esteves	*Noesys*	18	Flexural resonance & density
Rosén & Co Maskin	*Rosgrade*	25	Longitudinal resonance
	Rosgrade plus	28	Longitudinal resonance & density
Innodura	*E-CONTROL model AC*	27	Longitudinal resonance & density
RemaSawco AB	*RS Strength Grader*	32	Laser tracheid grain angle
	RS Strength Grader Density	39	Laser tracheid grain angle & density
Ilkon	*STIG*	35	Portable, longitudinal resonance
M. Manfred Hudel	*MODULO*	38	Mechanical bending

*ID relates to the TG1 machine number for naming the ITT reports (settings tables). Note that machines 14 and 26 have different names depending on the manufacturer providing it.

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VTT	*Raute Timbergrader*	3	Mechanical bending
Microtec s.r.l. – GmbH	*EuroGrecomat-702*	4	X-ray
	Goldeneye 702/802	5	X-ray
	EuroGrecomat-704	6	X-ray & mechanical bending
	Viscan	8	Longitudinal resonance
	EuroGrecomat-706	9	X-ray & longitudinal resonance
	Goldeneye 706/806	10	X-ray & longitudinal resonance
	Viscan Plus	20	Longitudinal resonance & X-ray density
	Viscan Compact	22	Longitudinal resonance & density
	Viscan portable with balance	29	Portable, longitudinal resonance & density
	Viscan portable without balance	30	Portable, longitudinal resonance
Microtec AB (Microtec Linköping)	*WoodEye Strength Grader*	31	Longitudinal resonance,density & laser tracheid grain angle
Microtec Innovating Wood Oy (Microtec Espoo)	*Finscan Nova*	36	Camera scanning (visual & near infrared)
	Finscan HD	37	Camera scanning (visual)
Dynalyse AB	*Dynagrade*	7	Longitudinal resonance
	Precigrader	12	Longitudinal resonance & density
Brookhuis Applied Technologies BV	***MTG 960***	11	Portable, longitudinal resonance & density
	mtgESCAN 962/966	14	Longitudinal resonance & density
	MTG 920	19	Portable, longitudinal resonance
	MTGbatch 962/966	23	Longitudinal resonance & density
	MTGbatch 922/926	24	Longitudinal resonance
	mtgESCAN 922/926	26	Longitudinal resonance
Dimter GmbH	*Grademaster*	13	Longitudinal resonance, density & knots
Luxscan technologies	***Escan FWM/FW***	14	Longitudinal resonance & density
	EScan FM/F	26	Longitudinal resonance

Microtec AB (Microtec Linköping)	*WoodEye Strength Grader*	31	Longitudinal resonance,density & laser tracheid grain angle
Microtec Innovating Wood Oy (Microtec Espoo)	*Finscan Nova*	36	Camera scanning (visual & near infrared)
	Finscan HD	37	Camera scanning (visual)
Dynalyse AB	*Dynagrade*	7	Longitudinal resonance
	Precigrader	12	Longitudinal resonance & density
Brookhuis Applied Technologies BV	***MTG 960***	11	Portable, longitudinal resonance & density
	mtgESCAN 962/966	14	Longitudinal resonance & density
	MTG 920	19	Portable, longitudinal resonance
	MTGbatch 962/966	23	Longitudinal resonance & density
	MTGbatch 922/926	24	Longitudinal resonance
	mtgESCAN 922/926	26	Longitudinal resonance
Dimter GmbH	*Grademaster*	13	Longitudinal resonance, density & knots
Luxscan technologies	***Escan FWM/FW***	14	Longitudinal resonance & density
	EScan FM/F	26	Longitudinal resonance
	OptiStrength XE	33	X-ray & longitudinal resonance
	OptiStrength X	34	X-ray
Concept Bois Structure SARL	*Triomatic*	15	Ultrasonic time of flight & pin indentation density
Automatisation J.R.T Inc	*CRP*	16	Mechanical bending
XYLOMECA	*Xyloclass T*	17	Longitudinal resonance & density
	Xyloclass F	21	Flexural resonance & density
SARL Esteves	*Noesys*	18	Flexural resonance & density
Rosén & Co Maskin	*Rosgrade*	25	Longitudinal resonance
	Rosgrade plus	28	Longitudinal resonance & density
Innodura	*E-CONTROL model AC*	27	Longitudinal resonance & density
RemaSawco AB	*RS Strength Grader*	32	Laser tracheid grain angle
	RS Strength Grader Density	39	Laser tracheid grain angle & density
Ilkon	*STIG*	35	Portable, longitudinal resonance
M. Manfred Hudel	*MODULO*	38	Mechanical bending

*ID relates to the TG1 machine number for naming the ITT reports (settings tables). Note that machines 14 and 26 have different names depending on the manufacturer providing it.

Microtec AB (Microtec Linköping)	*WoodEye Strength Grader*	31	Longitudinal resonance,density & laser tracheid grain angle
Microtec Innovating Wood Oy (Microtec Espoo)	*Finscan Nova*	36	Camera scanning (visual & near infrared)
	Finscan HD	37	Camera scanning (visual)
Dynalyse AB	*Dynagrade*	7	Longitudinal resonance
	Precigrader	12	Longitudinal resonance & density

Manufacturer	Machine	Machine ID	IP type	Date added
Rema Sawco AB	Strength Grader Density	39	Laser tracheid grain angle & density	2021
Microtec s.r.l - GmbH	Goldeneye 901	40	Laser tracheid grain angle & density	2024
Microtec s.r.l - GmbH	Goldeneye 902	41	Laser tracheid grain angle & density	2024
Microtec s.r.l - GmbH	Goldeneye 906	42	Laser tracheid grain angle & longitudinal resonance & density	2024

SARL Esteves	*Noesys*	18	Flexural resonance & density
Rosén & Co Maskin	*Rosgrade*	25	Longitudinal resonance
	Rosgrade plus	28	Longitudinal resonance & density
Innodura	*E-CONTROL model AC*	27	Longitudinal resonance & density
RemaSawco AB	*RS Strength Grader*	32	Laser tracheid grain angle
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*ID relates to the TG1 machine number for naming the ITT reports (settings tables). Note that machines 14 and 26 have different names depending on the manufacturer providing it.

Home grown

- Machine grading
  - Spruce (Useful: C16 → C24)
  - Pine (Useful: C16 → C24)
  - Larch (Useful: C20 → C27)
  - Douglas-fir (Useful: C18 → C27)
  - Also a new combination larch and Douglas-fir

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https://doi.org/10.1080/20426445.2022.2050549

Example, UK grown larch

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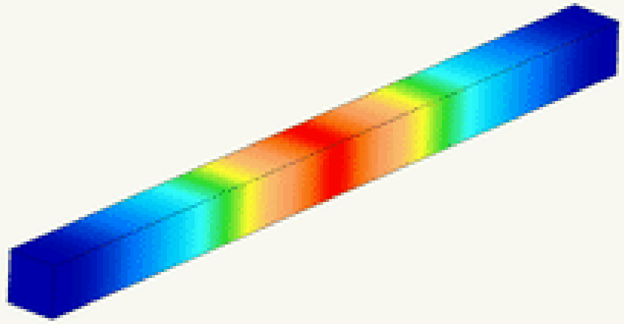
The Brookhuis MTG is a resonance type machine



Example, UK grown larch

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[MOEdyn] = [Density] × [Speed of sound]^2

$$IP_u = \left(\frac{M_u}{T_u \times W_u \times L_u}\right) \times (2 \times L_u \times f_u)^2 \qquad (1)$$

[Speed of sound] = [Wavelength] × [Frequency]

[Wavelength] = 2 × [Board length]

(With an adjustment for moisture content)

Sampling for machine control (Report: TG1/201703/26rev2)

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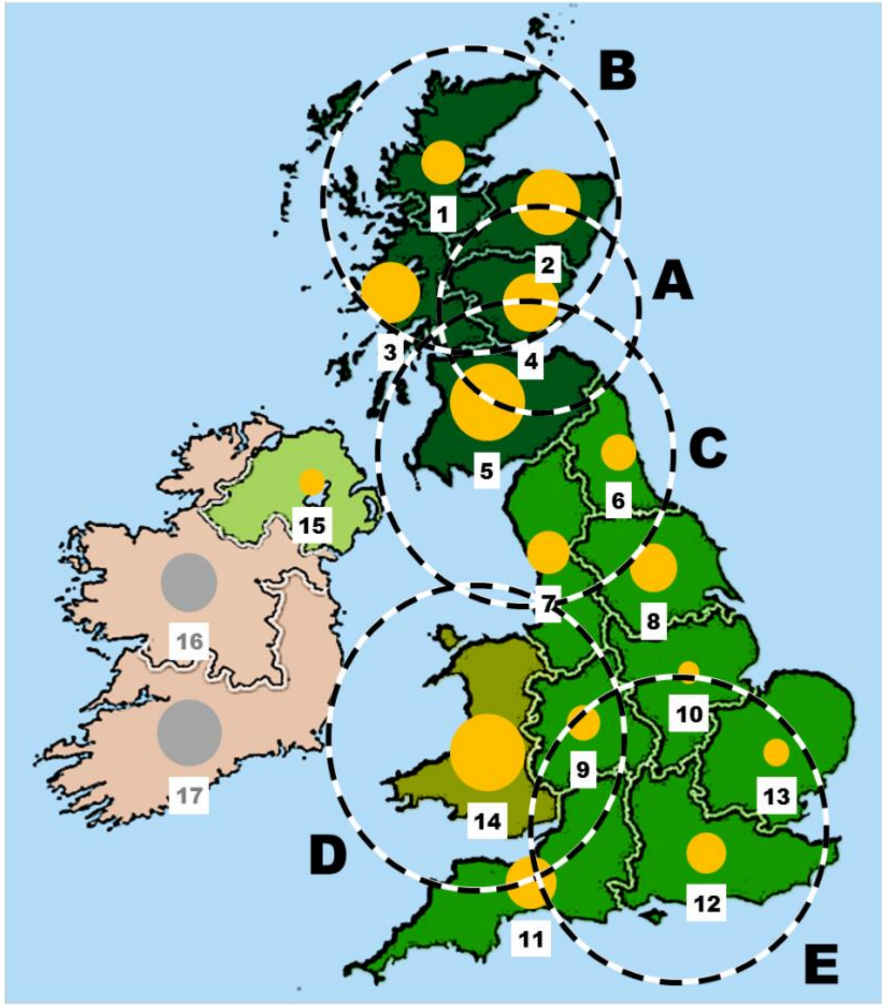

Nominal dimensions		Included in grading analysis (number of pieces)				
Thickness (mm)		47	47	75	100	Total
Width (mm)		100	150	150	275	
Subsample	Country					
A	UK	166	17	0	0	183
B	UK	63	0	40	13	116
C	UK	63	0	40	14	117
D	UK	63	0	40	13	116
E	UK	63	0	40	14	117
Total		418	17	160	54	649

Source country or countries	United Kingdom of Great Britain and Northern Ireland	
Species	European larch	*Larix decidua*
	Hybrid larch	*Larix x eurolepsis*
	Japanese larch	*Larix kaempferi*
	(WLAD)	
Permitted timber sizes		
Thickness:	42 mm to 112 mm	
Width:	88 mm to 307 mm	

UK larch with mtgBATCH 962

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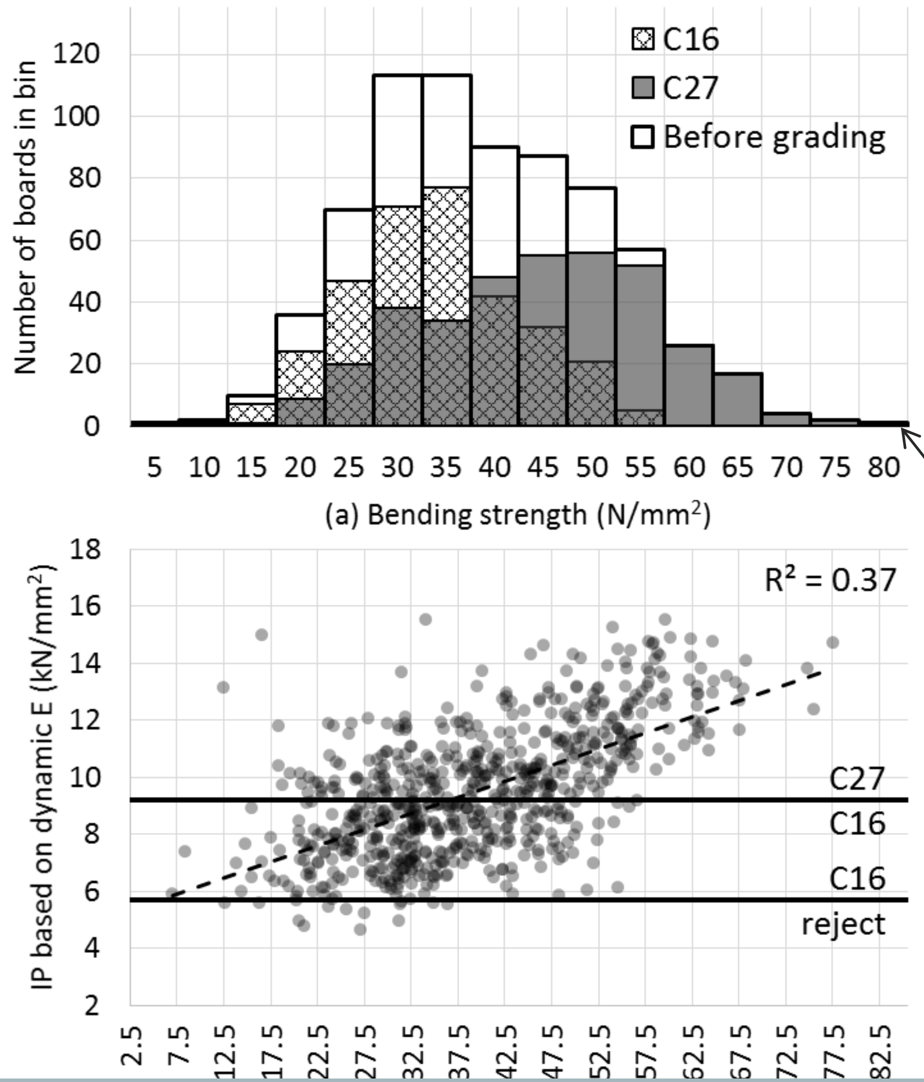

	% of required		
	Bending strength	Bending stiffness	Density
Class	%	%	%
C16	143% ✓	105% ✓	129% ✓
C27	100% ✓	103% ✓	122% ✓

Strength

Note there is still a large variation within the grades – the difference is we now have characteristic values

UK larch with mtgBATCH 962

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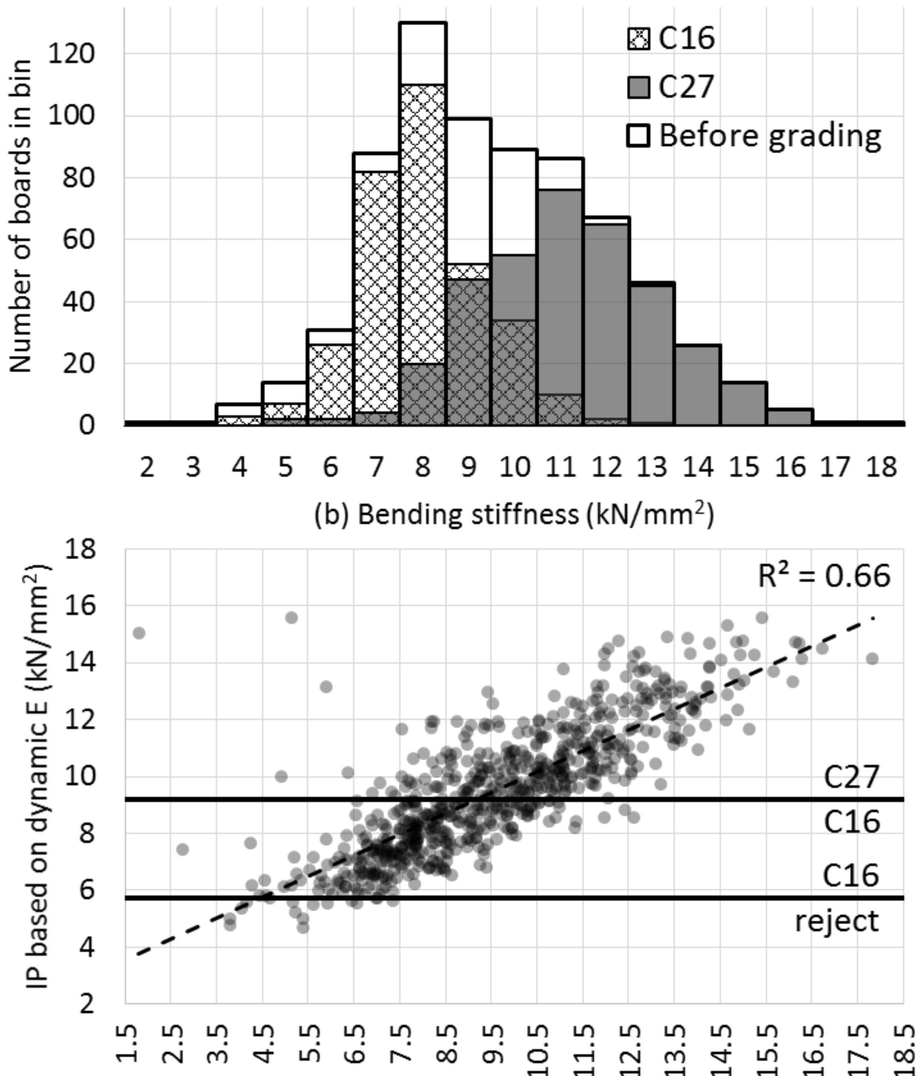

	% of required		
	Bending strength	Bending stiffness	Density
Class	%	%	%
C16	143% ✓	105% ✓	129% ✓
C27	100% ✓	103% ✓	122% ✓

Stiffness

UK larch with mtgBATCH 962

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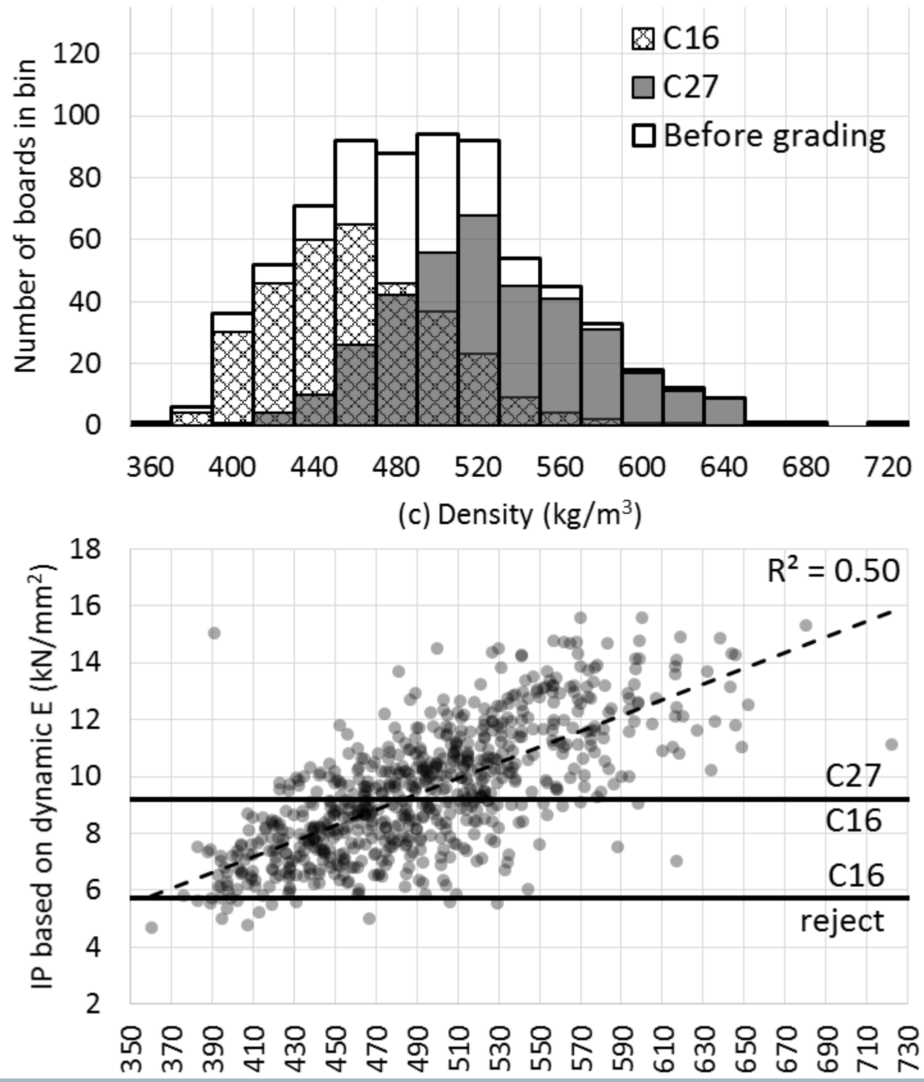

	% of required		
	Bending strength	Bending stiffness	Density
Class	%	%	%
C16	143% ✓	105% ✓	129% ✓
C27	100% ✓	103% ✓	122% ✓

Density

Using E_{dyn} as IP for density because it's not critical. Simpler this way – no point using density from weight (which has $R^2 = 0.85$)

Finding the right balance

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- If grading passes something that doesn't really have the right qualities, this is a bad error
- If grading rejects something that did have the right qualities this is less bad
- So grading should be weighted on the cautious side

- Risk, reject rates & the cost of the process (& the relative price the rejects can be sold for)

Visual override

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- Distortion (might be by machine)
- Fissures
- Wane
- Soft rot and insect damage
- Knots and slope of grain on any portion that cannot be machine graded (i.e. the ends of the timber for bending type machines)
- Anything else that causes concern

"Dry-graded"

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- Means, specifically, checked for fissures and distortion at a moisture content of no more than 20%
- Grading might have been done green
- Not the same thing as moisture content specification
  (so specify the moisture content separately)
- No direct correspondence with service class

One key difference

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- Visual
  - Relatively easy to check afterwards because the rules for the grading are known
- Machine
  - Difficult to check afterwards because full details of the grading are not usually known
- Verification
  - Via grade stamps and paperwork
  - Or testing (EN14358)

Grade stamps

- Visual
  - Can be on the piece or the package
- Machine
  - Must be on the piece
- UK position
  - Piece marking is important because of the risk of unmarked graded timber being mixed up on site
  - UK National Annex to Eurocode 5 applies a different partial factor for material properties:
    Individually marked $\gamma_m = 1.3$
    Package marked $\gamma_m = 2.0$

Grade stamps

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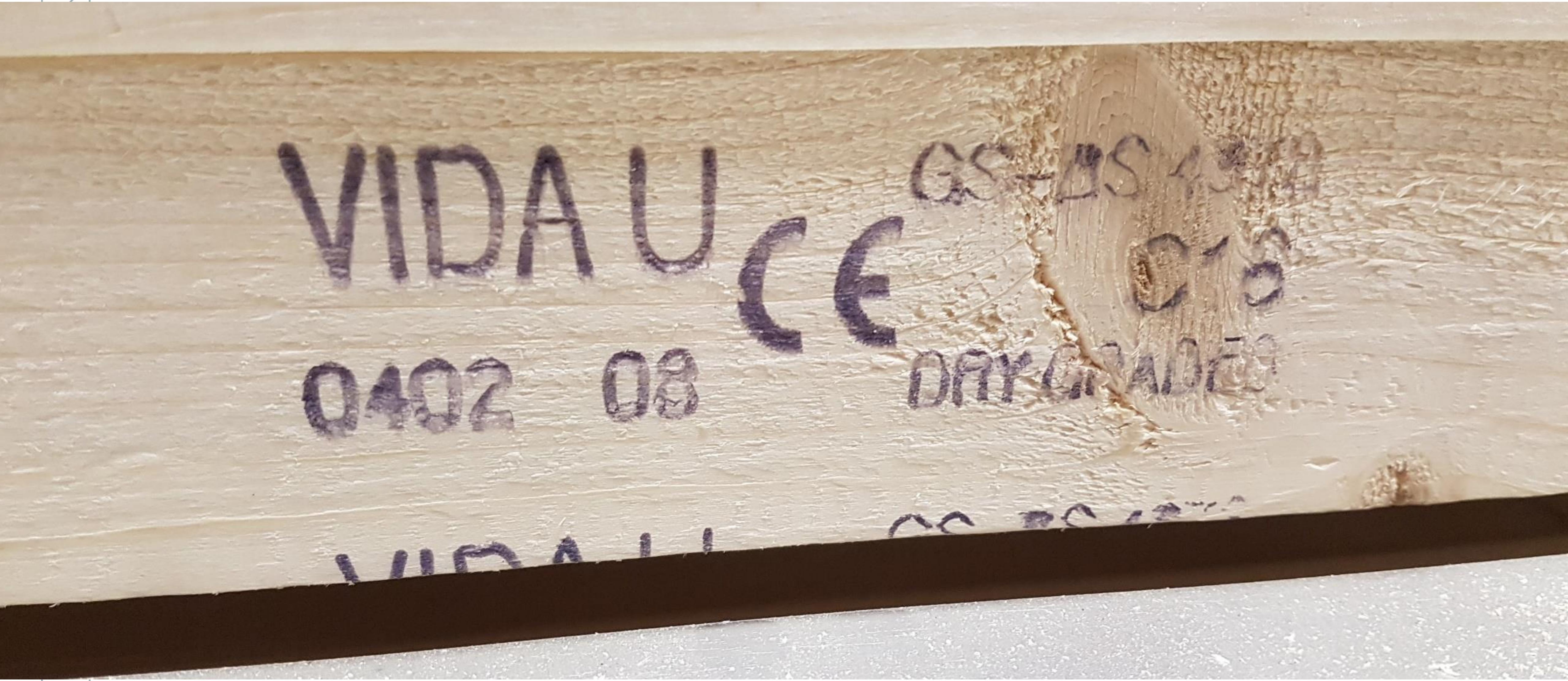
(Home-grown C16)

Grade stamps



(Imported C16)

Grade stamps

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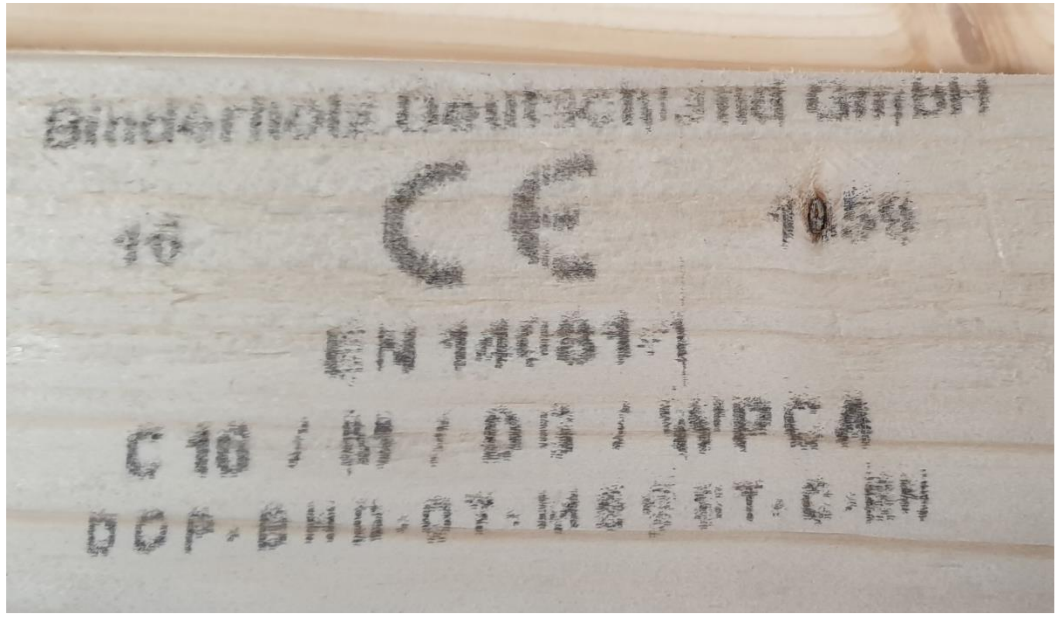

(Imported C16)

Standards

- EN 14081 strength graded structural timber
- EN 338 sizes and permitted variations
- EN 384, EN 408, EN 14358 testing & calculations
- Machine grading settings (“ITTs” or “AGRs”)
- Visual grading rules
  - e.g. BS 4978, IS 127, DIN 4074, NF B52-001-1
- EN 1912 some visual grading assignments
- Other assignments
  - Private & e.g. PD 6693 (British Standards Institution)

EN1912 revision

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~~Fpr~~EN 1912:2024 (E)

https://blogs.napier.ac.uk/cwst/en1912-species/

3.1
Caribbean
Bahamas, Belize, Colombia (Northern part), Costa Rica, Cuba, El Salvador, Guatemala, Honduras, Mexico (South Eastern part), Nicaragua, Panama

3.2
Central Europe
Austria, Belgium, Czech Republic, France (Alsace region), Germany, Hungary, Italy (Northern part), Liechtenstein, Luxembourg, Netherlands, Poland, Slovakia, Slovenia, Switzerland

3.3
Eastern Europe
Azerbaijan, Belarus, Georgia, Moldova, Romania, Russia (European part: Northwest Russia, Volga, South Russia, North Caucasus), Ukraine

3.4
Nordic countries
Denmark, Finland, Iceland, Norway and Sweden

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EN1912 revision

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Table 1 — Assignment of grades of species to bending (C) strength classes

Strength Class	Grading standard	Grade	Timber species: Commercial name(s)	Timber species: Botanical name(s)	Source	Basis of assignment a
C35	TS 1265:2012	Class 1	Anatolian black pine	*Pinus nigra subsp. pallasiana*	Türkiye	TC124–2021
C35	DIN 4074--1:2012	S13, S13K	Douglas fir	*Pseudotsuga menziesii*	Germany and Austria	TC124–2011
C35	ÖNORM DIN 4074--1:2012	S13, S13K	Douglas fir	*Pseudotsuga menziesii*	Germany and Austria	TC124–2011
C35	TS 1265:2012	Class 1	Scots pine (redwood)	*Pinus sylvestris*	Türkiye	TC124–2022
C35	UNE 56546:2022	MEF	Shining gum	*Eucalyptus nitens*	Spain	TC124–2022
C35	TS 1265:2012	Class 1	Turkish red pine	*Pinus brutia*	Türkiye	TC124–2022

EN1912 revision

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~~Fpr~~EN 1912:2024 (E)

Table 3 — Assignment of grades of species to tension (T) strength classes

Strength Class	Grading standard	Grade	Timber species		Source	Basis of assignment [a]
			Commercial name(s)	Botanical name(s)		
T24	UNE 56546:2022	MEF	Shining gum	*Eucalyptus nitens*	Spain	TC124–2022
T22	DIN 4074-1:2012	S13	European larch	*Larix decidua*	Austria, Czech Republic, Germany, Italy (North) and Switzerland	TC124–2020
T22	ÖNORM DIN 4074-1:2012	S13	European larch	*Larix decidua*	Austria, Czech Republic, Germany, Italy (North) and Switzerland	TC124–2020

EN14081-1 scope

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- Sawn rectangular timber
- Constant cross-section
- Untreated, except for preservative
- Known growth area and species

- Strength grading of timber that has already been graded is not allowed, except under very specific conditions

Re-grading

- Has to be done if the cross-section has changed beyond the permitted limit

- But has to be done with caution
- You cannot visually grade timber that has been machine graded (and not changed cross-section)

Some key points

- Strength grading is not about properties of *individual* pieces of timber – it is about the population of graded timber
- Having the same strength class does not make pieces (or sets of pieces) equal
- Species & growth area are very important – because relationships we use in grading are often not transferable between species or places

Some key points

- C16 is sufficient for many things
- There is no need to over specify
- It is a waste of money, a waste of wood, and limits options for where to buy

- If C16 is not sufficient for the design, often the design can be adjusted to make it work with C16

More

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For a fuller description of strength grading in Europe see:

Ridley-Ellis, D., Stapel, P., and Baño, V.: Strength grading of sawn timber in Europe: an explanation for engineers and researchers. European Journal of Wood and Wood Products, 74(3): 291-306, 2016.

SCAN ME

Building from England's Woodlands

- WP1 Project management
- **WP2 Wood properties categorisation**
- WP3 Optimised engineered timber products
- WP4 Pilot manufacture and prototype testing
- **WP5 Outreach and education**

Funded by the
Timber in Construction Innovation Fund
Woods into Management Forestry Innovation Funds

Forestry Commission

Main species of interest

- Beech
- Oak
- Birch
- Sycamore
- Ash
- Poplar
- Sweet chestnut
- Alder

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Hardwood and difficult wood

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- Ability to measure indicating properties
- Correlation if IPs strength
- Properties profiles – especially density
- Secondary properties and adjustments

- Expense of testing compared to the size of the resource

Machine grading hardwoods

▪ Sweet chestnut (Italy)	2014
▪ Poplar (France)	2019
▪ Southern blue gum (Spain)	2021
▪ Beech (Spain)	2024
▪ Birch (Sweden)	expected

The end?

But wasn't it graded already?

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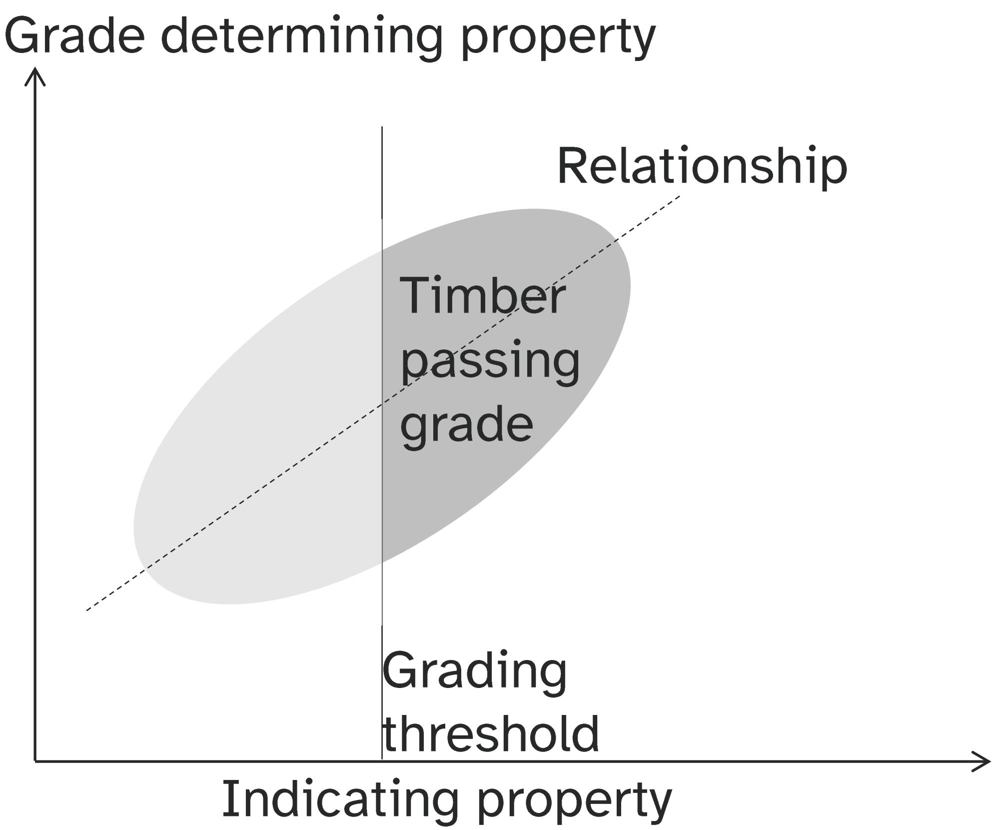

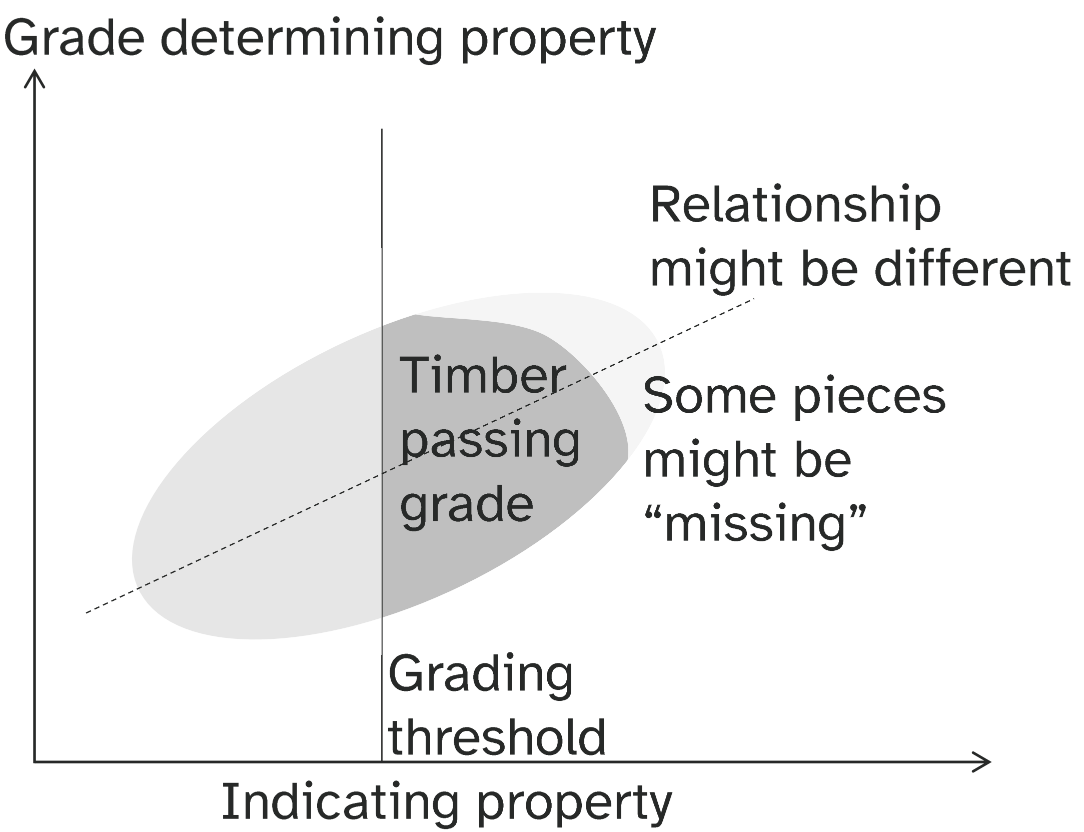

Need a new approach

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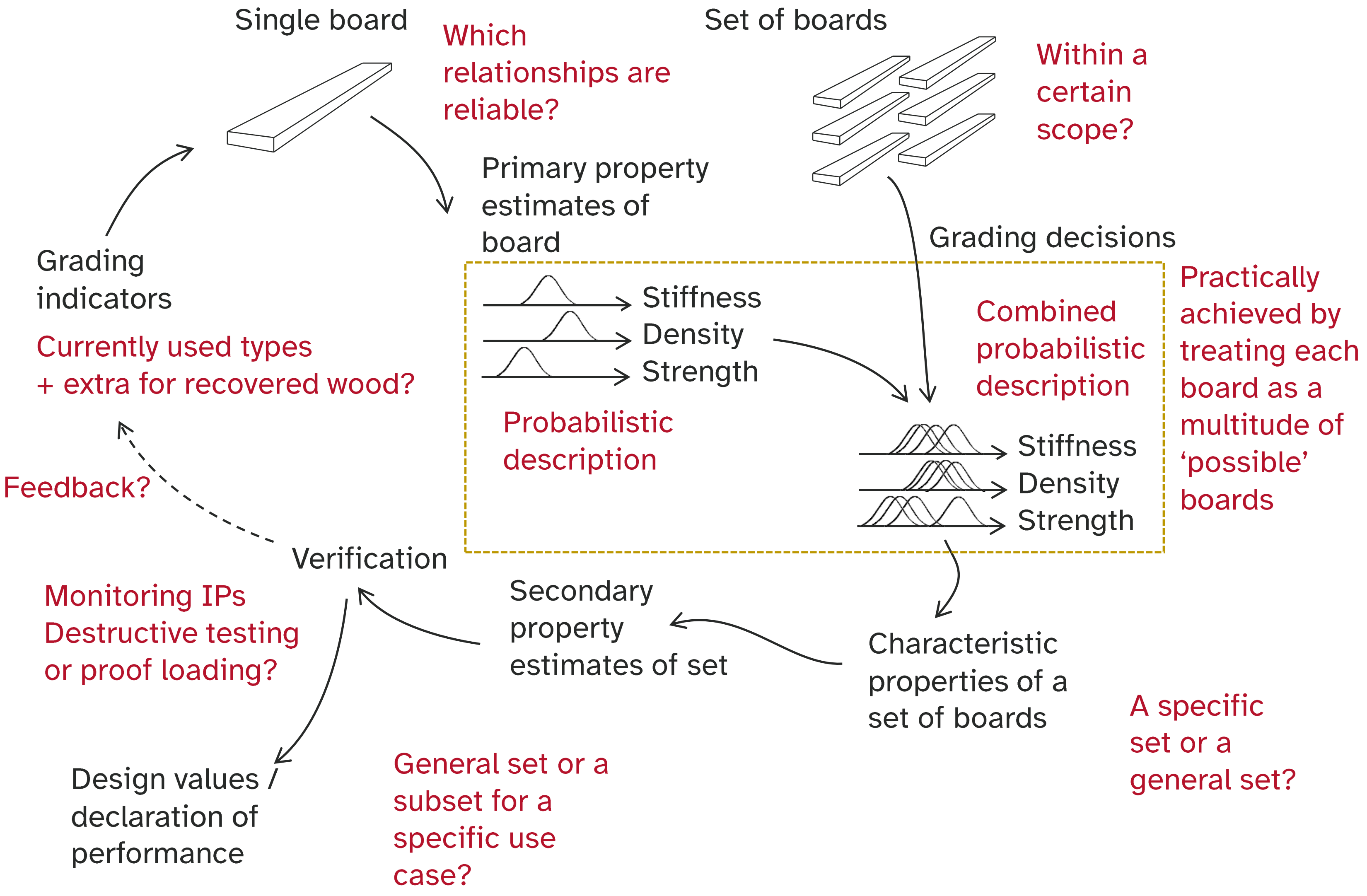
InFutURe Wood

www.infuturewood.info

SCAN ME



Actually… a bunch of "blind spots"

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- Tree forks and branches
- Roundwood generally
- Anything not rectangular, notches, tapers etc
- Anything modified or treated (except preservative)

…there are ways, if you know them…

Same basis for visual and machine

The underlying basis is EN14081-1 for both. Neither method can *directly* assess strength so they work by relating indicators to test data or long standing practice. (Although it is not always strength that governs the grading)

Strength classes - just convenience

Strength classes like C16 and C24 are a convenient way of talking about design values for timber on the general market – but they aren't always the best way of making full use of the real properties of the timber

You cannot easily regrade timber

Since grading relies on knowledge of the starting population, you cannot re-grade timber without taking account of the change. This is true for both visual and machine strength grading.

Summary

SIRT

Strategic Integrated Research in Timber

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Thank you!

blogs.napier.ac.uk/cwst/